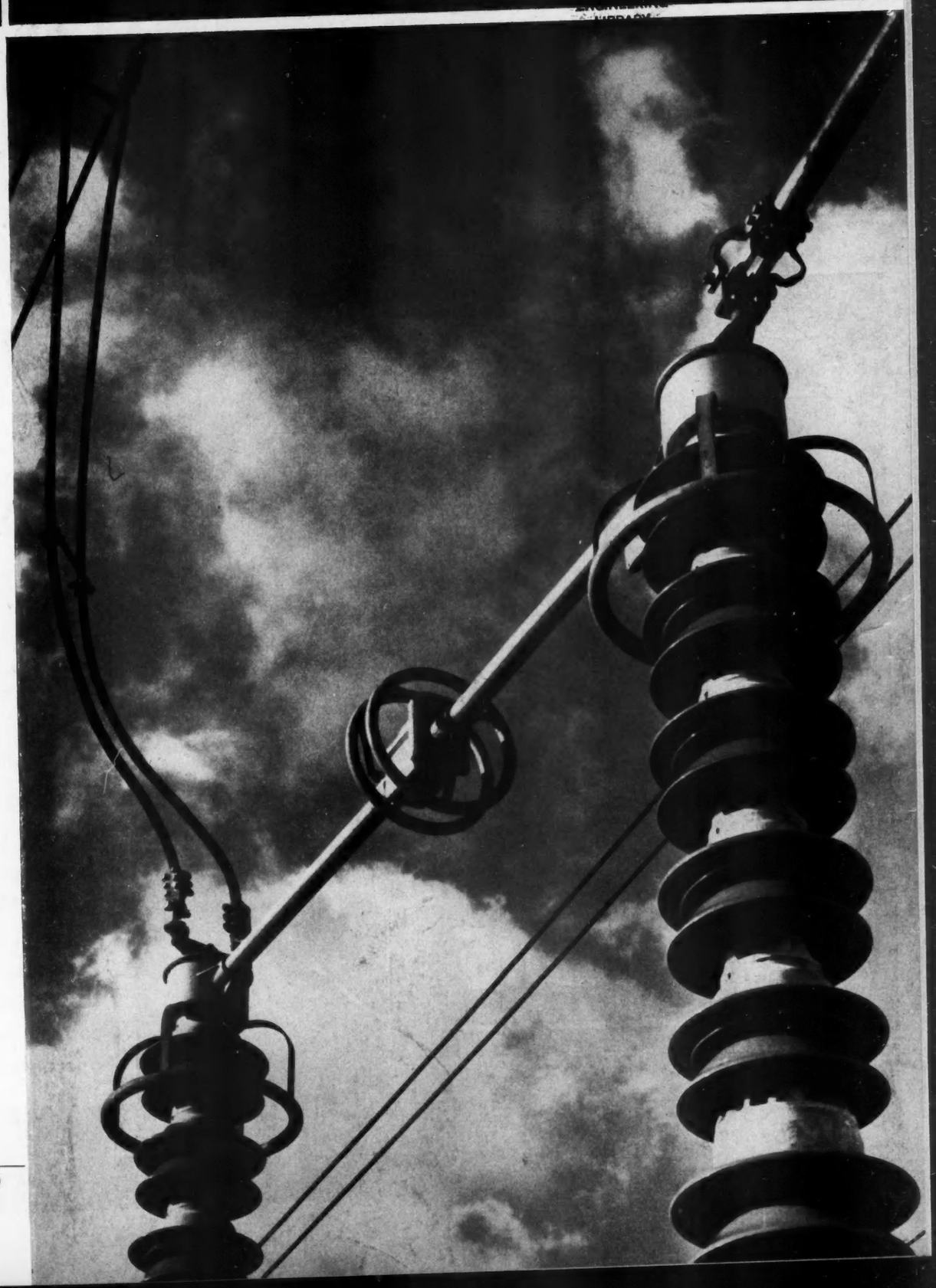
# ENGINEERING



*earch Report:*
**a High Pressure Effects Solids**

*ign:*
**h Water from water: New Evaporators**

*struction:*
**Glulam Stresses ncreased Safely?**

*nic Review:*
**hing Burst Slugs**

*uction:*
**oler Designs plicate Production**

*ls and Materials:*
**shing Stainless Steel e Easier**

*uct Profile:*
**ns Fliptop aging Machine**

*mobile Review:*
**r and Elegance ontinental Cars**

*Reviews:*
**tive Effort for ay Modernization**

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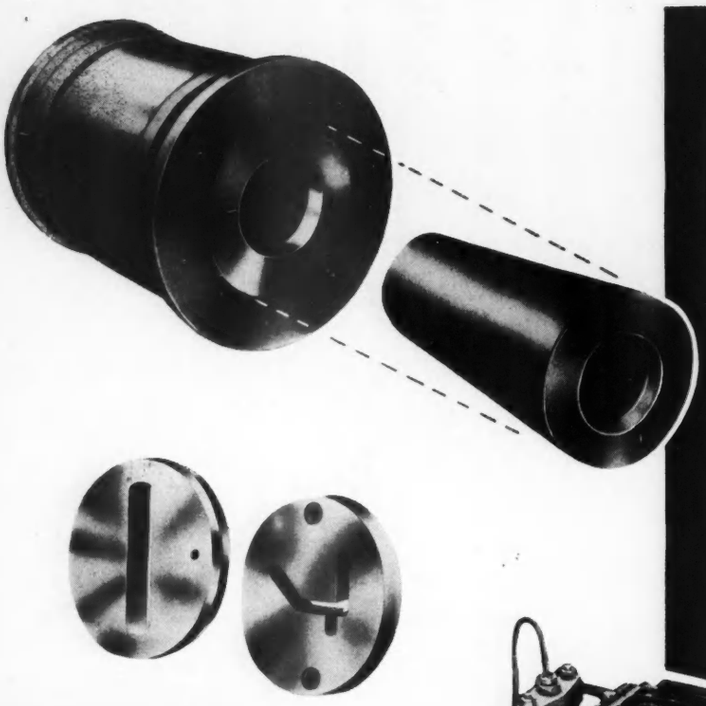

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# Contents

**586 Metals and Materials**

Polishing Stainless Steel Made Easier
*By J. P. Dewar*

Silicone Treatments for Masonry, Soft Thread for Transit Covers, Two Greases, Non-Crushable Rubber Hose, Bonded Aluminium Lorry Panels, Distillation Plant for Crude oil, Copper from Ore without Melting, Plating Process Defects in Zinc Die Castings

**590 Construction**

Can Glulam Stresses be Increased Safely?
*By W. A. Chugg*

**596 New Plant and Equipment**

Induction Furnace, Detachable Dumper, Polygon Shaping Machine, Trace Reader, Frequency and Capacity Meter, Marking Counter

Upsetter, Laboratory Mixer, Water Meter, Liquid Level Control, Liquid Earthing Resistor, Hanger

Truckmixer, Tractor Shovel, Vacuum-Pressure Pump, Electrostatic Paint Spray, Transistor Tester, Flameproof Starter

**602 Production**

Simpler Designs Complicate Production

More Coal Won by Machine, New Hydraulic Bench Press, Producing Colour Oxides for Ceramics, Prototype Carton Board Creaser

**604 Design**

Fresh Water from Sea: New Evaporators

Ocean Going Liner Built for Navigating a River, More Turbo-generators for the Large Power Stations

**613 Research**

Research Report:
Ultra-High Pressure Effects on Solids

Research Progress in Japanese Electronics, Lightweight Alloys for Space Engineering, Rapid Removal of Sulphur from Steel

**585 Impact**

**593 Human Element**

**601 Companies**

**609 Marketing**

**610 Product Profile**

The Molins Fliptop Packaging Machine

**Special Article**

**594** The Versatile Diesel Continues to Thrive

**592 Automobile Review**

Power and Elegance in Continental Cars
*By Gordon Wilkins*

**599 Atomic Review**

Catching Burst Slugs

**616 At Home**

Double Oven

**588 Plain Words**

*By Capricorn*

**588 Letters to the Editor**

Not Wisely but Too Well
*W. F. Cartwright*

Damping a Rotating Shaft
*Dr. E. Downham*

Tin in Demand
*John H. Trouson*

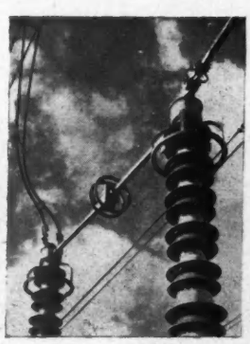
**589 Events in Advance**

**606 Publications**

On the Shelf
*By Frank H. Smith*

Railway Locomotives
British Locomotives
Engineering: The Professional and Elementary Problem Analysis
McGraw-Hill Encyclopedia of Science and Technology
Introduction to Mechanics, Matter, and Waves
Introduction to Modern Physics
Introduction to Quantum Mechanics
More Unusual Railways
World Railways, 1960
Railwayman

New Books and Trade Publications



**Cover Picture**

One phase of a 2,000 amp isolator (the other two phases are the overhead lines in parallel in the background). The unit, together with the earthing switch, is designed for a throughput of 15,000 MVA at 275 kV. The close-up shows the terminal heads, the line connectors, the contact arms and, in the centre of the photograph, the stress control rings.

Subscription Rates: Editorial page 616

Index to Advertisements: Overleaf

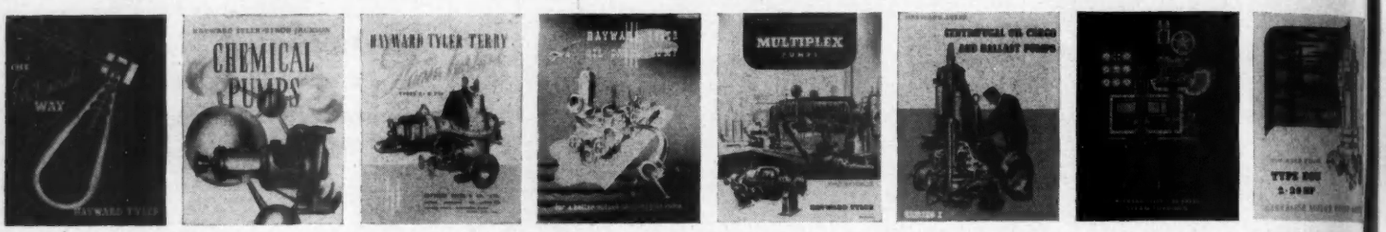
Engineering Appointment Section: Faces Editorial page 600

# Advertisers in 'Engineering' this week


| | PAGE |
|---|---|
| Abbot Eng'g. Co., Ltd. | 17 |
| Acru Electric Tool Mfg. Co., Ltd. | 4 |
| Adamson, Daniel, & Co., Ltd. | 60 |
| Associated Electrical Industries, Ltd. | |
| Motor & Control Gear Division. | 29 |
| Turbine - Generator Division. | 41 |
| Automotive Products Co., Ltd. | 47 |
| Balfour, Arthur, & Co., Ltd. | 28 |
| Barimar, Ltd. | 15 |
| Beard & Fitch, Ltd. | 57 |
| Beardmore, Wm., & Co., Ltd. | 25 |
| Belmos Co., Ltd. | 22 |
| Booth, Joseph, & Bros. | 64 |
| Borg & Beck Co., Ltd. | 47 |
| British Paints, Ltd. | 19 |
| British Steam Specialties, Ltd. | 40 |
| Broom & Wade, Ltd. | 21 |
| Brotherhood, Peter, Ltd. | 46 |
| Brown, David, Corpn. (Sales) Ltd. | 51 |
| Brown, N. C., Ltd. | 54 |
| Clyde Crane & Booth, Ltd. | 64 |
| Clyde Crane & Engineering Co. | 64 |
| Compoflex Co., Ltd. | 53 |
| Cox & Danks Ltd. | 57 |
| Crane, Ltd. | 18 |
| Crofts (Engineers), Ltd. | 49 |
| Dallow Lambert Ltd. | 30 |
| Davidson & Co., Ltd. | 45 |
| Davy and United Eng'g Co., Ltd. *Wrapper* | III |
| Douglas, Lawson & Co., Ltd. | 42 |
| Drysdale & Co., Ltd. | 8 |
| Dyson, R. A., & Co., Ltd. | 40 |
| Elliston, Evans & Jackson, Ltd. | 59 |
| Engineering "Reprints" | 15 |
| English Electric Co., Ltd. | 63 |
| Fafnir Bearing Co., Ltd. *Wrapper* | VIII |
| Fenner, J. H., & Co., Ltd. | 44 |
| Ferodo, Ltd. | 31 |
| Firth Brown Tools, Ltd. | 50 |
| Firth, Thos. & John Brown, Ltd. | 20 |
| Fleming & Ferguson, Ltd. | 15 |
| General Descaling Co., Ltd. | 61 |
| Govan Shafting & Engineering Co. | 60 |
| Greenwood's Standard Gear Cutting Co., Ltd. | 60 |
| H.M. Stationery Office | 4 |
| Hadfields, Ltd. *Wrapper* | II |
| Harland Eng'g. Co., Ltd. | 59 |
| Harvey, G. A., & Co. (London) Ltd. *Wrapper* | VII |
| Hayward Tyler & Co., Ltd. | 2 |
| Hick, Hargreaves & Co., Ltd. *Wrapper* | V |
| Holroyd, J., & Co., Ltd. | 34 |
| Hood, R., Haggie & Son, Ltd. | 61 |
| Howden, J., & Co., Ltd. | 37 |
| International Nickel Co. (Mond) Ltd. 9, 10, 11 & | 12 |
| Kempton, C. H., & Co., Ltd. | 43 |
| Klinger, R., Ltd. 26 & | 27 |
| Kompass Register, Ltd. | 5 |
| Lafarge Aluminous Cement Co., Ltd. | 6 |
| Laidlaw, Drew & Co., Ltd. | 42 |
| Lanarkshire Bolt, Ltd. | 19 |
| Leeds Eng'g. & Hydraulic Co., Ltd. | 4 |
| Londex Ltd. | 59 |
| Low, A., & Sons, Ltd. | 39 |
| Mason, E. N., & Sons, Ltd. | 16 |
| Midland Silicones, Ltd. | 58 |
| Modern Wheel Drive, Ltd. | 19 |
| Morgan Refractories Ltd. | 32 |
| Osborn, S., & Co., Ltd. | 52 |
| Pickering Group of Companies. | 56 |
| Polypenco, Ltd. | 40 |
| Pool, J. & F., Ltd. | 57 |
| Pulsometer Eng'g. Co., Ltd. | 14 |
| Regent Oil Co., Ltd. | 38 |
| Renold Chains, Ltd. | 24 |
| Reyrolle, A., & Co., Ltd. | 48 |
| Righton, H., & Co., Ltd. | 7 |
| Rocol, Ltd. | 62 |
| Seagers, Ltd. | 4 |
| Simplifix Couplings, Ltd. | 17 |
| Smith & McLean, Ltd. | 60 |
| Smiths Industrial Instruments, Ltd. | 54 |
| Steel Construction Co., Ltd. *Wrapper* IV & | 40 |
| Stein Atkinson Vickers Hydraulics Ltd. *Wrapper* | VI |
| Stephens Belting Co., Ltd. | 53 |
| Timber Development Association Ltd. | 33 |
| Tufnol, Ltd. | 35 |
| Turner Bros. Asbestos Co., Ltd. | 57 |
| Twiflex Couplings, Ltd. | 2 |
| United States Metallic Packing Co., Ltd. | 40 |
| Vaughan Crane Co., Ltd. | 23 |
| Visco Engineering Co., Ltd. | 13 |
| Ward, Thos. W., Ltd. | 55 |
| Warren-Morrison, Ltd. | 59 |
| Wiggin, H., & Co., Ltd. | 36 |
| Wigglesworth, Frank, & Co., Ltd. | 43 |
| Wilkinson Rubber Linatex, Ltd. | 54 |
| Wiseman, A., & Co., Ltd. | 14 |
| Youngs (Lifting Appliances) Ltd. | 43 |

| | PAGE |
|---|---|
| **'Engineering' Appointments Section** | inside Editorial Section |
| Admiralty | 4 |
| Associated Electrical Industries (Manchester) Ltd. | 1 |
| Booth, James, Aluminium, Ltd. | 2 |
| Borough Polytechnic | 1 |
| British Aluminium Co., Ltd. | 5 |
| British Hydrocarbon Chemicals, Ltd. | 5 |
| Brush Electrical Engineering Co., Ltd. | 6 |
| Central Electricity Generating Board | 4 |
| **Classified: Trade & Technical** | |
| B. G. Plant (Sales Agency) Ltd. | 3 |
| Edwards, F. J., Ltd. | 3 |
| Haseltine, Lake & Co. | 3 |
| Interpas, N.V. | 4 |
| Lanchester College of Technology | 3 |
| Monney, C. R. | 3 |
| Dewhurst & Partner, Ltd. | |
| Eastern Nigeria, Agent General for | |
| Laporte Industries, Ltd. | |
| Laing, John & Son, Ltd. | |
| Lever Brothers, Port Sunlight, Ltd. | |
| Management Selection, Ltd. | |
| Nigeria, Electricity Corpn. of | |
| Wellman Smith Owen Engineering Corpn., Ltd. | |
| Nigeria, Electricity Corporation of | |
| Norris Bros., Ltd. | |
| Nottingham, City of | |
| Research Engineers, Ltd. | |
| Snowy Mountains Hydro-Electricity Authority | |
| Ward, Thos. W., Ltd. | |
| **Company Meeting** | |
| Engineering Components, Ltd. | |



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# ENGINEERING Impact

## of a Chance to Break a Tradition

CLOSE ON the heels of the Russian man-in-space exploit, the consortium of British companies promoting a UK effort in space announces that a start is being made on plans for communications using space resources.

With the relatively modest launching rocket needed, and the advanced work already carried out by Hawker Siddeley and others, round the world communications using satellite stations almost certainly provide the attractive combination of being a form of space activity from which tangible benefits can be expected and of being open to United Kingdom industry to exploit.

British Space Development, the company led by Sir Robert Renwick, has set up a technical committee which includes some of the leading engineers and scientists working in Britain. Its chairman is Mr. G. K. C. Pardoe, who presided over de Havilland's Blue Streak team. It is of course not beyond the bounds of possibility that eventual British communications satellites could be launched by means of Blue Streak.

The task set out by BSD for its technical committee is to examine and prepare plans designed to achieve British participation with the minimum of delay. Its first priority is to submit proposals for the use of space for communications.

The founder members of the consortium are all companies who have made substantial contributions to engineering knowledge in recent years. The founders are: Associated Electrical Industries, Associated Television, British Insulated Callender's Cables, Decca Radar, Hawker Siddeley Aviation, The Plessey Company, Pye, Rank Television and General Trust, and Rolls-Royce.

A great deal of the world's intercontinental communication is carried on along British made cables. Over sea and land surfaces and in the air, most of the companies in the consortium have provided much of the equipment for communication and for navigation and traffic control.

In the past the British have gained an unenviable reputation for being first with developments and failing to follow them through. This time, coming late into space, we have to reverse the process and come out commercially in front.

## British Participation in Hydraulic Research Body

IT IS something of a surprise to learn, on the authority of the Institution of Civil Engineers, that there are in Great Britain only 46 members of the International Association for Hydraulic Research. This research association, set up in 1938, holds two-yearly congresses and, at closer intervals, symposia on the specialized topics of concern to hydraulics engineers.

The Institution of Civil Engineers has now set up a British National Committee for the joint porposes of organizing a British section of the international association and to coordinate and encourage the participation of British engineers and scientists.

At its meeting in Belgrade later this year the council of the association will be considering the invitation of the new British committee to hold the ninth congress of the International Association in London in 1963.

A detailed description of the Association, and application forms, for membership, are available from the secretary of the British section, the International Association for Hydraulic Research, c/o the Institution of Civil Engineers, London, SW1.

## Five Year Plan for Cyprus Development

CAPITAL expenditure of about £43 million in the development of the Cypriot economy is proposed by a United Nations economic survey mission which made a prolonged study of the island's resources.

The particular developments proposed are for the water resources, (Cyprus is semi-arid) agriculture, mining, forestry, roads and the establishment of a development bank for the financing of new ventures. Electricity generating capacity on the island is at present not sufficient to meet the expected expansion in demand of the next two years. It is even further from being able to cope with the sort of extra load that would be thrown upon it by even part of the development envisaged by the UN mission.

The detailed financial proposals of the survey mission suggest that £25 million of the proposed £43 million should be found over the next five years from the internal revenues of the island. Of the rest, to be raised externally, the United Kingdom has already concluded a £13 million aid agreement with Cyprus.

Britain's remaining military bases on the island are pointed out by the UN report as continuing to make an important contribution to the island's economic position. The mission's leader indicates that steps should be taken to encourage those staffing the bases to make the most possible use of the local goods and services.

The proposed experimental industrial expansion programme refers specifically to increasing production of beer, cement, cement-asbestos pipes, fertilizer and cigarettes. A programme costing almost £7 million is proposed for major extensions to the port facilities at Famagusta and Limassol and at two smaller ports.

For British engineering firms there are two considerations in relation to trade with Cyprus worth keeping in mind. The island can never be a large market but is in a strategic position. Close to Turkey and no great distance from other countries of the Eastern Mediterranean, Cyprus is something of a shopwindow.

It could also be a market of interest to the smaller exporter, for whom special provision has now been made in the revised terms of Export Credit Guarantee Department.

Implementation of the UN plan would mean that civil engineering, electricity generation and supply works and the acquisition of machinery and equipment would swiftly become among the first considerations of the island republic.

## of Heavy Engineering Over the Hump

THERE is a continuing thread through recent statements from the heavy and electrical engineering industries which suggests that the immediate future may be one of rather better times than these industries have been experiencing.

This has at once to be qualified with the recollection that home demand in the domestic appliance field is unlikely to revive to the hectic heights of a year or two ago and that a rough global count indicates that at the heavy side of these industries there is enough surplus capacity to keep the competition particularly exacting.

Surveying 1960, Vickers are able to report that their overall sales rose by 4 per cent, that there was no fall in trading profits, which is particularly encouraging with so many pressures working against income, and that the value of the total orders was up by 9 per cent.

Despite having to announce a considerable loss on the year, John Thompson's statement in effect closely parallels part of that from Vickers. John Thompson report that their order book is in a very healthy state and that future profits should be encouraging.

From Associated Electrical Industries, Lord Chandos' statement had been awaited with more than usual interest Two sections of the group, radio and television and domestic appliances, are expected to have a difficult year and the profit margins in export business are not predicted from AEI as likely to continue at anything other than inadequate. The more cheerful prospect is with four AEI divisions that have on previous occasions figured on Lord Chandos' list of difficult areas of the group's activities. They are nuclear power, telecommunications, lamps and cables. In all of them past losses, or too low profit margins, are now thought likely to change to better levels of surplus income. More favourable results are now expected from a majority of AEI divisions.

Linking the AEI statement and that of John Thompson, the Berkeley nuclear power station contract can now be seen to be responsible for more than half of AEI's £9 million overdraft and may be assumed to play perhaps the major role in John Thompson's declaration of a loss on the year. Dungeness, a station which is also being built with John Thompson should show some profit.

The influential United States journal *Business Week* declares in its current issue that the recent lengthening and improving of the facilities of the British Export Credit Guarantee Department give Britain export credit facilities that are second to none in the world and in advance of a great many countries.

Without taking that up in detail it is clear that the longer credit terms and the general pattern of the ECGD changes should act only to the advantage of the exporters of capital goods.

One other statement, from Reyrolle, that rapid improvement in orders in the last half of the year mean that the company's capacity will be busy for at least the next 12 months, serves to remind, through their research link with AEI, that all the competitors in these industries carry an immense burden of necessary research and development costs.

Whether or not the mergers have gone as far as need be, the future for which "slightly better" now appears to be the forecast is likely to see closer and closer association in research, and also possibly in marketing.

## Family Holidays in the United States

NO ONE has ever called the British a nation of air lovers. The Spitfire and Hurricane fighters and the United Kingdom's pioneering work on the jet engine have their place in history but still the 50 million or so British see themselves as a maritime nation.

For this reason, and also for simple employment in the shipyard considerations, it is distressing to see reports of an apparently well founded venture into really cheap Atlantic sea crossings discussing the provision of foreign ships for the probable new services or at least of ships converted to their new function in a Continental shipyard.

The travel expert and hotelier who has already moved tens of thousands of tourists by ship between the United Kingdom and Canada, Africa and Australia and New Zealand now proposes the permanent use of ships of around 24,000 tons, fully air conditioned and with individual cabins and ample recreational provision, crossing the Atlantic in five to six days at about £70 return—a 50 per cent cut on existing rates. Two trial voyages may take place this summer.

The implication for the liner building shipyards should on the whole be favourable. The tendency of the North Atlantic Passenger Conference has been to maintain Atlantic fares on the basis of the luxury crossing in the style of ship which, with a subsidy, Cunard are even now putting out to tender. But there is an analogy here with land bound travel, with the private motor car, that is worth considering.

Famous names in luxury motoring, Rolls-Royce and Daimler, continue. But their turnover is minimal compared with the Austins and Fords driven in their millions. The position that the top luxury cars occupy, for all but the few that enjoy actual ownership, is that of a symbol; in terms of numbers of people employed and profits made it is all with the manufacturers providing personal transport at a less exalted level.

There is no mass market for Bentley cars and the trend into more and more air crossings (up from 1·3 million to 1·9 million in the last three years) suggests that there is no mass of would-be sea travellers ready to be wooed into sailing the Atlantic at today's fares.

But it is certainly arguable whether flying the Atlantic can be called an enjoyable experience. At rates matching the sort of holiday many more people can afford (every now and again) the evidence suggests that once Atlantic crossings at this sort of fare are started the numbers ready to use the service may grow very rapidly indeed.

The three week holiday is becoming increasingly common in Britain and in the Common Market countries. Five or six days out, a week in the United States, and the same run back would fit in very nicely. British ports are already well placed for these services. It is to be hoped that British shipyards obtain their share of the conversions and even construction that would be required.

# Polishing Stainless Steel Made Easier

**Polishing of stainless steel has been brought within reach of all firms by the introduction of improved mops and faster cutting abrasives.**

*By J. P. Dewar, O.C.T.(Birm.)*
*W. Canning and Company Limited*

STAINLESS steel can be polished mechanically with abrasive media, or by one of several electrolytic and chemical processes. If, however, a mirror finish is desired, it is still usual to resort to mechanical polishing, and several developments in mop texture and construction, coupled up with fast-cutting iron-free abrasives, have made this a process which can now be carried out by most firms with confidence. Until recently, polishing of stainless steel by any process had been confined to a few firms who were specialists in the art.

Producers of stainless steel have also helped the trade polisher by modifying the structure of the metal itself.

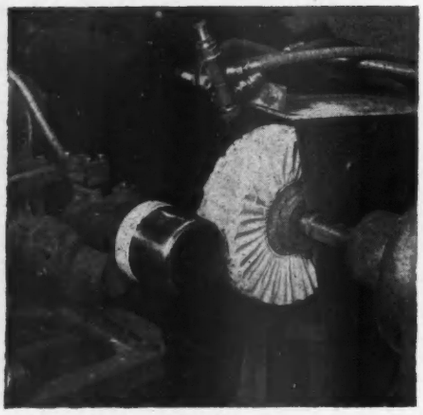
Among the improved polishing media now obtainable, W. Canning and Company offer a range of mops based on woven sisal under the name Stapol. They also make ventilated bias buffs normally referred to under the name Airflow. Four such mops are illustrated. Airflow mops are used extensively for bright polishing stainless steel sheets, strip and other components on automatic machines.

The cloth used in the Airflow sections is bias-cut. This means that the weft and warp threads are all about 45° to the mop periphery. The rate at which fibres are lost from the periphery is very much less than with normally cut disc mops, hence the life of the bias mop is much greater. Overheating is prevented by air cooling via the centre plates which have air ducts in them.

During recent years the impregnation of calico mops and polishing wheels has increased considerably. This enables polishing composition in bar or liquid form to adhere to the mop face more readily so that it remains on the wheel for a longer time. Impregnation normally leads to longer mop life, a saving in polishing composition, and a better surface finish in a given time because abrasive particles in the polishing composition stay on the mop for a longer time and cut more efficiently before being thrown from the mop face.

Impregnated sisal mops are also firmly established and show a saving in polishing costs compared with untreated sisal mops.

Polishing processes required for stainless steel depend on initial surface condition of the metal. As with other metals the complete polishing process usually comprises three stages: preliminary abrasive operations; bright polishing; and a final polishing or colouring operation.



*Liquid polishing composition applied by spray to a ventilated bias mop for semi-automatic polishing.*

*Typical surfaces after three stages of polishing from original. Note CLA readings.*

An abrasive medium called Aloxite is normally used for the preliminary abrasive operations. Some articles such as hot rolled sheets may require a grit size as coarse as 40 grit, but this would be followed by finer grit sizes until, after a final glazing operation with 180/220 grit —usually with a greased wheel—the metal is ready for bright polishing. Bright rolled stainless steel may require only the last of these preliminary operations with Aloxite. Abrasive-dressed wheels such as felt bobs, and stitched or unstitched mops could be used, or in many cases abrasive bands would be suitable with backstand idler equipment. Aloxite is usually bonded to the abrasive wheel with cold cement.

The stainless steel is now ready for bright polishing. This is the stage at which sisal mops used with iron-free abrasive composition have reduced polishing times compared with calico or fast cutting linen mops. The size of the mops depends on the type of component being polished, but it is recommended that 10 or 12 in diameter mops operating at 2,950 rpm should be used. Smaller mops can and are being used for difficult shapes.

As an example of time saved by using sisal mops, in one instance their use helped to eliminate a preliminary abrasive operation and so reduce overall processing time by about 30 per cent from 1½ hours to 62 minutes. The articles being processed were stainless steel sheets 8 ft long by 2 ft wide where the number of preliminary operations involved 80, 120, 180 and 220 grits followed by bright polishing. When sisal mops were used the process involved 80, 180 and 240 grits followed by a sisal mop operation and a quick polishing operation with a calico mop.

After bright polishing, stainless steel is usually given a final colouring operation using an 8 or 10 in diameter mop made from soft finishing cloth, with a polishing composition containing green chrome oxide. This gives a fine surface finish.

The top illustration shows how reflectivity increases after each of these three stages. Corresponding CLA surface roughness values are shown below it. The final value of 2·8 micro-in is typical of what the trade expects to obtain (2 to 3 micro-in) although one seldom finds this specified.

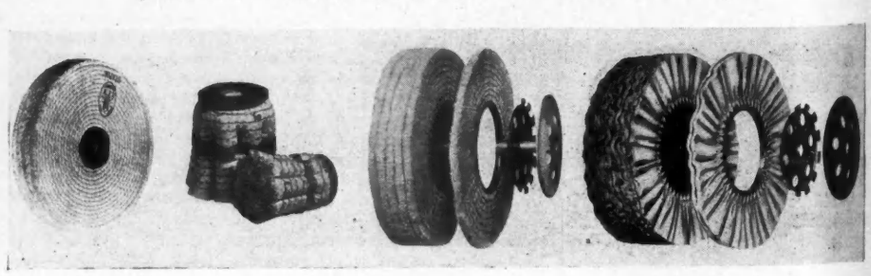
| Preparation | Surface roughness CLA value, micro-inches |
|---|---|
| Initial condition | 10·8 |
| 220 grit Aloxite | 8·3 |
| Stapol sisal polishing | 3·5 |
| Calico mop finishing | 2·8 |

Most stainless steel as supplied to the fabricator will require treatment by all the three foregoing steps if a mirror finish is required. Where, though, should one resort to semi or fully automatic machines in place of manual polishing? This depends on the availability of equipment to hold and move articles, on the cost of making jigs, and whether the work output demand warrants automatic equipment.

Great strides have been made in design of automatic polishing machines and they are now used for a variety of articles such as motor car hub discs, window frames, domestic holloware, cutlery, and medical and surgical equipment. The polishing composition in bar or liquid form is applied automatically in predetermined amounts to a given time cycle, which can be varied by an electric timing unit. Liquid compositions can be applied to the mop by means of spray guns such as the one shown which operates in conjunction with electric solenoid air valves. In some instances, the air valves are cam operated, while on semi-automatic polishing attachments, hand controlled or foot controlled air valves are used.

On semi and fully automatic polishing machines, bias type mops are generally used—in sisal for cutting operations, and calico for finishing. Large diameter mops are used on automatic polishing machines and 12, 14 or 16 in diameters are standard. Mops for polishing sheet have been made up to 6 ft wide and the standard diameters for this type of work are 15, 16 and 18 in. Mops are spaced to impart flexibility to the face and increase ventilation.

To sum up, there are now polishing media which are readily obtained, and which should make any firm confident in undertaking the preparation of stainless steel to a mirror finish.



(*Left to right*) *Sisal mop for taper screw spindle. Sisal bottom mops for internal polishing of holloware. Ventilated sisal sections. Ventilated calico bias buffs.*

## Copper from Ore without Melting

The end of the age-old method of producing copper through melting processes may be signalled in the Philippine Islands, where a proposed $23 million plant will soon turn low-grade ores into high quality copper—without a melting step anywhere along the line. This copper will then be converted into strip, tubing and wire at the same Philippine installation.

The basic processes are chemical leaching of the ores, gaseous reduction into metal, followed by newly developed rolling methods which form solid sections from the powdery reduced metal. In the last operation powder feeds from a hopper into compacting rolls. The strip then goes through a furnace to sinter the powder into a continuous product, and through a hot rolling mill to close up and internally weld the small voids between original powder particles.

E. W. Bliss Company will furnish its patented rolling and fabricating equipment for converting powder into strip. Sherritt Gordon Mines of Toronto who own and license the chemical reduction techniques will also participate. Foster Wheeler Corporation is the prime contractor for Marinduque Iron Mines Agents, Inc., who have been given approval for a loan of $13 million by the Export-Import Bank of Washington.

The plant will produce about 14,000 tons a year of fabricated copper products, as well as 100,000 tons of ammonium sulphate fertiliser and about 5,000 tons of zinc as the oxide or electrolytic metal particularly for use in the galvanising industry.

*E. W. Bliss Company, Canton, Ohio, USA*

## Plating Process Defects on Zinc Die Castings

A development report published by the British Non-Ferrous Metals Research Association is now generally obtainable (No. 64, 15*s*). It is an atlas of process defects which can occur during plating of zinc alloy die castings.

This association have surveyed over a thousand rejected plated castings. Three types of blistering, five types of pitting and several other defects are illustrated at about 8× magnification and remedies are suggested for getting rid of each.

*British Non-Ferrous Metals Research Association, Euston Street, London NW1.*

## Silicone Treatments for Masonry

Nubold Developments have been expanding their range of silicone treatments for masonry and other building materials and they have now published a ten page leaflet in an attempt to get over the advantages of their various grades.

Nubold comment in this that " some grounds for scepticism have been afforded by the exaggerated claims which have from time to time been put forward on behalf of silicone water repellent treatment as a panacea for all ills. The situation has been further aggravated by the absence of a British Standard specification for silicone water repellent solutions which has tempted manufacturers to market products with too low a silicone content to ensure a long life for the treatment."

Products made by this company conform to American Standard Specifications—the only ones in existence (" All efforts to reach agreement on a British Standard Specification have so far proved abortive," they say)—and have been tested in the field in all types of climate over the past five years " with uniformly satisfactory results."

There are four main products, Nubindex, Nubex Standard, Nubex T4 and Nubex W. Nubindex is the latest development and this product (or its variant which incorporates a fungicide) is used to treat new porous masonry surfaces of any type where it is desired to secure maximum water repellency and maximum resistance to hydrostatic head such as the pressure produced by wind-driven rain or sea spray.

Nubindex products incorporate a bonding agent which has the effect of strengthening the material treated and bonding together loose particles on the surface of it. They are therefore claimed by Nubold to be of particular value for use on weaker mortars which are used with softer building stones. These two products are more expensive than Nubex Standard and Nubex W which don't have binders and it is recommended that they should be specified for all buildings falling within cases C and D of the British Standard Code for Functional Requirements of Buildings (CP3), chapter 5, and probably also for those in case B.

*Nubold Development Limited, The Mount, Crawley, Sussex.*

## Two Greases

Bardahl Products have added two new greases to their range. The first is called No-Melt and has high temperature resistance; the other is calcium based and is water repellent.

The first of these is said to be capable of staying on bearings at temperatures up to 538° C. There is no drop point for this type of grease. The second is an addition to the range of calcium soap based greases made by this company and is intended for low temperature work where moisture or water has proved excessive for other greases. Bardahl claim their greases have more than ordinary staying power because of additives such as polar organic compounds which have an affinity for metals.

*Bardahl Products Limited, 39 Craven Road, London W2.*

## Bonded Aluminium Lorry Panels

The side and rear panels of a lorry recently delivered to the Delta Metal Company of Greenwich are constructed by bonding aluminium skins to inner ribs with Redux adhesive made by CIBA (ARL).

CIBA comment that this bonded construction eliminates the unsightly cracking of paint around rivet heads, and by the use of piano hinges, completely smooth sides can be obtained which simplify painting and cleaning. Panels for this lorry were made by Bonallack Limited with aluminium supplied by James Booth Aluminium.

*CIBA (ARL) Limited, Duxford, Cambridge.*

## Soft Thread for Transit Covers

Terylene polyester fibre sewing thread is now being used by John Smith and Company (London) on their transit covers to replace harder flax thread. This is being done to avoid the possibility of scratching highly polished surfaces.

These covers can be used over and over again, and were devised to replace cardboard and similar containers for transporting such items as furniture, radio and television sets, for both consumer and industrial markets. An outer protection of jute is lined with thick felt, and there is an inner lining of soft cotton calico. These three materials are quilted together and are normally tailored to fit.

The company comment that interesting developments of this design have also been made for recording-engineers' instrument slings to protect the equipment and limit vibration, and for thermal insulation and protection of ice cream refrigerated transit boxes. For the latter, treated material is used which will withstand low temperatures and possible contact with freezing salt for long periods.

*John Smith and Company (London) Limited, Hainault Road, Chadwell Heath, Essex.*

## Non-Crushable Rubber Hose

A water suction hose designed for use where hose is subjected to damage from lorry movements is being marketed by Goodyear of America. It is called Rebound—because it springs back to its original shape after being completely crushed (claim Goodyear). The hose is being produced in lengths up to 25 ft and in 1½ and 2 in diameters.

The shape of the hose is maintained by a treated rope helix embedded in heavy rubber between the two plies of fabric reinforcement. This helix is also claimed to prevent collapse of the hose at high vacuum.

The interior tube of the hose is a non-porous rubber compound which resists action of sand and grit and is also impervious to mildly acid and alkaline water. In America it is being stocked with straight ends but can be made with enlarged ends apparently to order. This hose is not marketed in Great Britain but Goodyear say it may be here in the near future.

*Goodyear Tyre and Rubber Company (GB) Limited, Bushbury, Wolverhampton, Staffordshire.*

## Distillation Plant for Crude Oil

ICI are to build a plant capable of distilling about 1 million tons of crude oil annually on a site on the north bank of the River Tees. Agreement has been reached with Shell-Mex and BP whereby they will make available to ICI the crude oil for processing. The plant will cost several million pounds and is due for completion before the end of 1962.

The Heavy Organic Chemicals Division of ICI, which will be responsible for building and operating the distillation plant, has not previously handled crude oil in its petroleum chemicals manufacturing operations. The plant will consist essentially of a distillation unit designed to give flexibility, in order to permit a variety of crudes to be processed and to vary the end product.

*Imperial Chemical Industries Limited, Millbank, London SW1.*

# Plain Words

*By Capricorn*

NOSTALGIA, it seems to me, even an undue fondness for tradition, can be deadly. To many who have cherished the steam locomotive in its prime, those quaint old tank engines with their dizzy dominating stovepipes and evocation of Will Hay still seem "apparelled in celestial light." But is it not likely that this same affection has helped to hinder progress on the railways?

Aircraft development, unlike the older industries of shipbuilding and railway engineering, has always been subject to the relentlessness of mathematics—and the importunate demands of war. But aircraft, like ships and locomotives, have always commanded an enthusiastic following, a band of loving connoisseurs, who argue over SE5's and Sopwith Camels with the partiality and fervour that art critics might devote to Masaccio or Cranach. And always they reserve the most affection for the machines that coincided with their own years of immaturity, those years of sweet association and livelier perception.

That is why when I read in a recent issue of the *Bristol Siddeley Journal* the title "Last of the Gladiators" I felt a sudden pang of sentimental regret. The Gloster Gladiator once had seemed to me the perfect fighter aircraft and now the last of the line had made its final flight and been relegated to the Valhalla of the Shuttleworth Collection.

Early in 1939, long before Faith, Hope and Charity had won lasting fame in the defence of Malta, I wrote to the Gloster company for line drawings of the Gladiator so that I might build a model accurately to scale. Drawings were kindly sent to me, and I was very much impressed to discover that they were marked "Confidential. Please return promptly," or words to that effect. My friends were equally impressed and I allowed them to believe that I was working for the Government.

Came September, 1939, and before the model was completed I and my friends were hastily evacuated—not, as I think it was A. P. Herbert protested at the time, pumped out, but sent to a safer place. The plans must have been packed away with other things, but in any case I never saw them again. Many times during the next months I expected to have the police or MI5 knocking at my door. But the knock never came.

Since those days I have always had a soft spot for the Gloster Gladiator with its little Bristol Mercury engine. Maybe 260 mph wasn't fast but it was jolly good for a biplane. And aeroplanes have never been the same since biplanes disappeared. The Gloster Javelin, a worthy successor and no doubt a most effective military machine, means little more to me than optimised geometry, a confection of triangles and tubes.

Those plans have always left me with a guilty conscience, an unresolved responsibility. But now the Gladiator has finally withdrawn from active service, I can come into the open. I hope the Gloster Aircraft Company—and MI5—have forgiven me.

## Letters to the Editor

### Tin in Demand

SIR, The statistics of world production and consumption of tin which you published (ENGNG., 7 Apr. '61, p. 473) are worthy of the most serious consideration by all concerned with the supply of metals vital to Britain's industries. There is, however, another aspect of the problem which is rarely mentioned and which few people in this country appear to understand, and that is the tremendous potential demand for tin of Russia, India and China. The present consumption of those countries in relation to our own is best illustrated in tabular form.

| Country | Population in millions | Consumption per head of population in pounds per annum | Consumption per head expressed as a fraction of that in the United Kingdom |
|---|---|---|---|
| United Kingdom .. | 52 | 0·93 | 1 |
| USSR .. .. | 209 | 0·18 | 1/5 |
| India .. .. | 361 | 0·02 | 1/46 |
| China .. .. | 640 | 0·02 | 1/46 |

The combined populations of the USSR, India and China are 23 times as large as that of the United Kingdom yet, whereas we use 21,000 to 23,000 tons of tin per annum, their total consumption is at present only about 25,000 tons.

It has long been observed that the consumption of tin in any country is closely related to the degree of industrialization, and this holds good in spite of all attempts at substitution. Therefore, in view of the declared intention of the USSR and China to expand their industrial production as fast as possible, and also bearing in mind India's rapidly increasing industrialization, the potential demand for tin from those three countries, with their enormous populations, is indeed tremendous. When it is realised that consumption throughout the rest of the world is expanding fast and that production is declining, and is likely to do so progressively, then it becomes apparent how serious is the problem of future tin supplies.

An eminent authority on world tin affairs has recently stated that, in his view, the position is so serious that this country should be doing everything possible to encourage the production of tin from its own not inconsiderable resources. It is therefore most regrettable that, in his Budget, the Chancellor of the Exchequer has again failed to take any action to encourage the expansion of the tin mining industry in this country. The official line is that we should reduce imports and expand exports, but by its own fiscal policies the Government makes it practically impossible for our indigenous mining industry to revive and so provide the country with the tin which will become increasingly difficult and expensive to obtain from overseas in the not distant future.

Yours truly,
JOHN H. TROUNSON,
Chairman,
Cornish Mining Development Association.
Redruth,
Cornwall.
18 April, 1961.

### Damping a Rotating Shaft

SIR, I have read with interest the article by Professor R. E. D. Bishop on the whirling of a bent shaft (ENGNG., 25 Nov. '60, p. 735) and the subsequent discussions on the subject (ENGNG., 23 Dec. '60, p. 848, and 3 Mar. '61, p. 312).

It appears to me that, if instead of representing the system under consideration by idealized "massive particles" and imaginary lines representing shaft "centres" one were to consider the geometry and construction of a practical system, there can be no difference in the dynamic behaviour of a so-called bent shaft and one which is unbalanced.

For example, a shaft could be prefabricated by mounting thin discs on a spindle. The discs, for the sake of argument, would be bonded together to form an integral system.

In Fig. 1 (*a*) such a system is constructed by mounting discs which have been drilled through their centres of gravity on a spindle which has been deliberately bent, the two outer discs being used as bearing journals. This may be described as a "bent" shaft.

On the other hand if instead of balanced discs on a bent axis the system of Fig. 1 (*b*) were applied in which a straight spindle is used on which are mounted discs which have been drilled eccentrically such that the locus of the centres of gravity is similar to the bent spindle axis of Fig. 1 (*a*), then here we have a system which could be described as a straight shaft with unbalance and which would be balanced in the appropriate manner by restoring the centres of gravity to the axis of the spindle

Within the context under consideration I can see no difference between these two systems and the concept of motion about the effective flexural axis would appear to be equally applicable to both cases. Therefore, if as in the classical Jeffcott approach, damping is assumed to act at the point of attachment between shaft and rotor for the straight shaft-unbalanced rotor system, then equally should the damping in the "bent" shaft case be assumed to act at the "effective flexural axis" rather than rotor centre of gravity or so called shaft axis.

In any case it would be dangerous to generalize on damping as my own experiments have shown considerable damping forces in a plain bearing and, with electrical machinery or turbo machinery with non-uniform gas or steam flow, it would be difficult to determine exactly where the resultant damping forces would act.

Finally, I would draw attention to the case of the turbine shaft in which it is difficult to see where the rotor starts and the shaft finishes. As an example, consider the configuration shown in Fig. 2, where *ab* and *ef* represent the bearing journals which establish the spin axis of the solid rotor shown. Turbine blades would be attached along the section *cd* which would be accurately machined with respect to the journals.

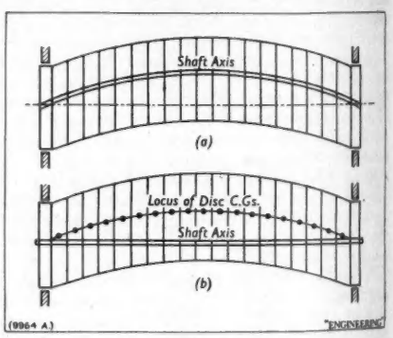



*Fig. 1*

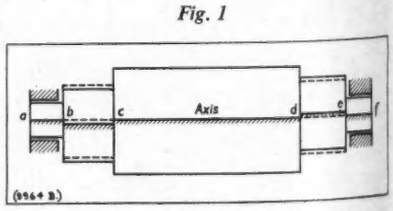



*Fig. 2*

The stepped sections *bc* and *de* would not, in general, be machined to the same tolerances as the bladed section and could be imagined as being eccentric with regard to the axis through the journal centres. If now we say that the shaft axis is the locus of the centres of area along the shaft, then the so-called shaft axis would be as shown. Is this a "bent" axis or is the rotor simply unbalanced due to the eccentricity of two of the sections? It would appear that if the section between the bearings had been bored to fit a plain shaft of the same diameter as the journals, then this would be classified as a straight shaft with an unbalanced rotor. Are we, therefore, to assume that if the shaft rotor system is turned out of the solid that this is a bent shaft and should be treated differently?

In conclusion, I would ask the questions: when is a shaft not a shaft but a rotor, and is not this shaft axis criterion analogous to the definition of the equator one learnt at school, i.e. an imaginary "lion" running through the centre of the shaft?

Yours faithfully,
E. DOWNHAM.

College of Advanced Technology,
Birmingham, 4.
14 April, 1961.

### Not Wisely but Too Well

SIR, Might I concur with the views expressed in the Plain Words, published in your issue of 7 April, in which Capricorn points to the danger of doing things too well. I believe it was Donald Nelson, head of the War Production Board in America during the last war, who stated that "blind insistence on perfection" did a great deal of damage to the war effort.

I think, while this fact is fully understood by everybody who gives it a moment's consideration, it is frequently overlooked. As an ex-army man with our company used to say, "never lose sight of the object in trying to improve the method."

Yours faithfully,
W. F. CARTWRIGHT,
Asst. Managing Director and General Manager.

The Steel Company of Wales Limited,
Steel Division,
Port Talbot, Glamorgan.
17 April, 1961.

## Events in Advance

## World Interest in Food Technology

CONSIDERABLE progress has been made during recent years in all aspects of food preservation, processing and packaging. The many problems encountered are to form the subject of the First International Congress of Food Science and Technology, which will be held in London from 18 to 21 September, 1962, and over which Lord Rank has accepted an invitation to preside.

Technical sessions will take place at the Imperial College of Science and Technology, South Kensington, London, SW7. Subjects to be covered will include the chemical and physical aspects of food and food processing; biological and microbiological aspects; texture, flavour, colour and keeping properties; processing and packaging; quality control; distribution; education; and health aspects.

Visits will be paid during the course of the congress to university departments, food factories, and government and industrial laboratories. Social events being arranged will include an official reception and a banquet. Although the congress is being organized by the United Kingdom, as the host country, it is being arranged on a world-wide basis, and speakers and delegates are expected from a wide range of overseas countries.

It is intended to set up an international committee from among the representatives of societies throughout the world and to empower this body with authority to decide international policy for future food congresses and similar activities.

The executive committee responsible for the 1962 congress includes Dr. H. D. Kay, C.B.E., F.R.S. (chairman), Dr. A. J. Amos, Dr. E. C. Bate-Smith, Mr. A. P. Buchanan, Dr. J. B. M. Coppock and Lieut-Colonel F. J. Griffin, the honorary secretary. Additional information may be obtained from Colonel Griffin, First International Congress of Food Science and Technology, 14 Belgrave Square, London, SW1. (Telephone: BELgravia 3681.)

## Exhibitions and Conferences

**Automatic Vending Exhibition, Third International.**—Mon., 15 May, to Fri., 19 May, at the Royal Horticultural Society's New Hall, Greycoat Street, London, SW1. Sponsored by the Automatic Vending Machine Association, 51 Lincoln's Inn Fields, London, WC2. Organised by Contemporary Exhibitions Ltd., 2 Dunraven Street, Park Lane, London, W1. Tel. HYDe Park 5421.

**Self Service, Venders and Shop Display Exhibition.**—Mon., 15 May, to Fri., 19 May, at Olympia, London, W14. Organisers: Self Service Exhibitions Ltd., 74 Holland Park, London, W11. Tel. PARk 7460.

**Waste Heat Recovery from Industrial Furnaces, Conference.**—Mon., 15 May, to Fri., 19 May, at Bournemouth. Coinciding with the conference will be an exhibition of plant and equipment illustrating the recovery of waste heat. Applications should be made to the secretary, Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. Tel. LANgham 7124.

**Hospital Equipment and Medical Services Exhibition, Third International.**—Mon., 15 May, to Sat., 20 May, at Olympia, London, W14. Organised by Contemporary Exhibitions Ltd., 2 Dunraven Street, Park Lane, London, W1. Tel. HYDe Park 5421.

**Nuclear Electronics, Conference.**—Mon., 15 May, to Sat., 20 May, in Belgrade. Apply to the International Atomic Energy Agency, Kaerntnerring, Vienna 1, Austria.

**Television Equipment Trade Fair, First International.**—Mon., 15 May, to Sat., 27 May, at Montreux. Organised by the World's First International Festival of Television Arts and Sciences, 8 Grand-Rue, Montreux.

**British Sole Leather Fair, Third.**—Tues., 16 May, to Thurs., 18 May, at St. Ermin's Hotel, Caxton Street, London, SW1. Including leather-preparing machinery. Organised by the United Tanners' Federation, Leather Trade House, 17-19 Barter Street, London, WC1. Tel. HOLborn 9784.

**British Upper Leather Fair, Fourth.**—Tues., 16 May, to Thurs., 18 May, at St. Ermin's Hotel, Caxton Street, London, SW1. Including leather-preparing machinery. Organised by the United Tanners' Federation, Leather Trade House, 17-19 Barter Street, London, WC1. Tel. HOLborn 9784.

**Footwear Components Exhibition, Third.**—Tues., 16 May, to Thurs., 18 May, at the Washington Hotel, Curzon Street, London, W1. Open to the trade only. Organised by the Exhibition Department, *Footwear*, Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

**Engine Testing of Crankcase Lubricating Oils, International Symposium.**—Wed., 17 May, to Fri., 19 May, at Brighton. Organised by the Engine Tests of Lubricants Panel of the Institute of Petroleum. Offices of the Institute: 61 New Cavendish Street, London, W1. Tel. LANgham 3583.

**Paris International Trade Fair, 51st.**—Thurs., 18 May, to Mon., 29 May, in Paris. In the United Kingdom, applications should be made to the French Chamber of Commerce, 74 Brook Street, London, W1. Tel. HYDe Park 2744.

**Budapest Industrial Fair.**—Fri., 19 May, to Mon., 29 May, in Budapest. Organised by the Hungarian Chamber of Commerce, 17 Rosenberg h.p.u., Budapest V, Hungary.

**British Trade Fair in Moscow.**—Fri., 19 May, to Sun., 4 June, at Sokolniki Park, Moscow. Open to trade and public. British capital and consumer goods. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

## Events in Advance

## Meetings and Papers

### British Institution of Radio Engineers

LONDON
"Television Wireless Distribution"; Discussion, to be opened by L. Tye, K. A. Russell and R. J. Seacombe. Television Group. London School of Hygiene and Tropical Medicine, Keppel Street, London WC1. Wed., 17 May, 6 p.m.*

FARNBOROUGH
"Electronic Techniques in the Measurement of Acoustic Noise," by K. R. McLachlan. Southern Section. Farnborough Technical College. Tues., 16 May, 7 p.m.

### Institute of Physics and the Physical Society

LONDON
Special Meeting to consider and approve for submission to the Council the draft constitution and rules of the Low Temperature Group, at 2.30 p.m. Tea at 3.30 p.m. Discussion on "Very Low Temperature Engineering," to be introduced by M. Zvegintzov, at 4 p.m. Wed., 17 May.

### Institution of Civil Engineers

LONDON
"St. Lawrence Power Project—Hydraulic Features," by O. Holden. Tues., 16 May, 5.30 p.m.*

### Institution of Electrical Engineers

LONDON
"Circuits for the Banana Tube Colour Television Display System," by K. G. Freeman; "Mechanical and Manufacturing Aspects of the Banana Tube Colour Television Display System," by H. Howden; "Appraisal of the Banana Tube Colour Television Display System," by K. G. Freeman and B. R. Overton; "The Banana Tube Display System: A New Approach to the Display of Colour Television Pictures," by Dr. P. Schagen; "Colorimetry of the Banana Tube Colour Television Display System," by R. N. Jackson; and "The Banana Tube," by B. A. Eastwell and Dr. P. Schagen. Electronics and Communications Section. Mon., 15 May, 5.30 p.m.*
"Air Traffic Control," by Dr. E. Eastwood and Dr. B. J. O'Kane. Electronics and Communications Section. Wed., 17 May, 5.30 p.m.*

EDINBURGH
"Electricity Supply in India and Its Future," by Dr. M. Datta. Annual General Meeting. South East Scotland Subcentre. Carlton Hotel. Tues., 16 May, 7 p.m.

MANCHESTER
"Protection of High-Voltage Systems from Lightning Faults," by Dr. R. H. Golde. Annual General Meeting. North Western Centre. Engineers' Club, Albert Square, Manchester. Tues., 9 May, 6.15 p.m.

SHEFFIELD
"Progress in Permanent Magnet Material," by J. E. Gould. Annual General Meeting. Sheffield Subcentre. Grand Hotel, Sheffield. Wed., 17 May, 6.30 p.m.

### Institution of Electronics

LONDON
"Aerial Techniques," by C. F. Whitbread. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Fri., 19 May, 7 p.m.*

BIRMINGHAM
"Tunnel Diode Circuit Applications," by I. Aleksander. Birmingham Branch. New College of Technology, Gosta Green, Birmingham 4. Thurs., 18 May, 7 p.m.

### Institution of Mining and Metallurgy

LONDON
"Reaction of Beryl with Sodium Fluorosilicate Used in Extracting Beryllium from the Mineral," by K. R. Hyde, Professor P. L. Robinson, M. J. Waterman and Dr. J. M. Waters; and "Dispersion of Tin in Soil Over Mineralisation at Sungei Lembing, Malaya," by Dr. J. S. Tooms and S. Kaewbaidhoon. Geological Society, Burlington House, Piccadilly, W1. Thurs., 25 May, 5 p.m.*

### Institution of Plant Engineers

BLACKBURN
"Electronics," by J. Siddon. Blackburn Branch. Castle Hotel, Blackburn. Thurs., 18 May, 7.30 p.m.

CARDIFF,
"Measurement and Analysis of Noise in Factories," by G. Berry. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 23 May, 7.30 p.m.

### Institution of Production Engineers

BRIGHTON
"Cost Accounting's Contribution to Production Efficiency," by S. C. Comber and R. E. Turner. Brighton Group. Old Ship Hotel, King's Road, Brighton. Wed., 17 May, 7 p.m.

### Institution of Public Health Engineers

LONDON
"A Comparison of the Behaviour of Various Media in Percolating Filters," by G. A. Truesdale and K. Jones. Caxton Hall, off Victoria Street, SW1. Wed., 17 May, 6 p.m.

### Royal Society of Arts

LONDON
"Bauxite and Its Importance to the Commonwealth," by Wilfred Brining. Henry Morley Lecture. Thurs., 25 May, 5.15 p.m.*

### South Wales Institute of Engineers

CARDIFF
"Cable Belts Underground in Coalmines," by Lister Walker and A. E. Hiscox. Thurs., 18 May, 6 p.m.

**The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated.** An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 8 Bedford Square, London, WC1. (MUSeum 1901)
Institute of Physics and the Physical Society, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Electronics, 78 Shaw Road, Thornham, Rochdale Lancs. (Oldham Main 6661)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Public Health Engineers, 179–181 Vauxhall Bridge Road, London, SW1. (VICtoria 3017)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296)

# Can Glulam Stresses Be Increased Safely?

**On what principles should an increase in the present working stresses for glued laminated timber be based, and what safeguards should be introduced into the Code of Practice?**

*By W. A. Chugg, F.I.A.C., A.I.W.Sc.*

*Timber Development Association*

THE glulam industry has always considered itself restricted because, though "horizontal" beams with the laminations assembled approximately parallel to the neutral plane are usually manufactured, only the "vertical" type, with the laminations assembled at right-angles to the neutral plane, are considered in the existing version of the British Standard Code of Practice, CP 112, 1952.[1] This means that no special working stresses are available to those engineers who desire to design glulam structures, though it is generally agreed that for certain applications, where deflection and other considerations do not limit design stresses, these could be higher for laminated work than for large solid timber members.

The existing Code of Practice makes no attempt to deal with the design and manufacture of glued laminated timber structures because, at the time it was prepared, only limited information was available on this method of construction. The working stresses which appear in the Code are therefore applicable to timber sections used more or less as sawn from the felled tree.

If new working stresses are to be established then the reasons for the greater strength of laminated over solid timber members must be fully understood.

Tests have indicated that, aside from the beneficial effect of dispersion of imperfections, the act of gluing pieces of timber together to form a structural member does not, of itself, make the resultant laminated timber any stronger than a similar size solid timber member, unless the laminations are so thin that the glue bonds significantly affect the strength of the member and, for structural work, the boards are too thick for this to occur.[2]

For this reason also, the same engineering formulae as are used in solid timber design are in general applicable to glued laminated timber structures, since the glue lines, if properly made, should have shear strength equal to that of the timber and the laminated member should behave in the same manner as solid timber.

As the adhesive bestows no special structural advantages on a laminated member, on what factors does the increased strength of glued laminated timber members depend?

## Moisture Content

The first factor affecting its strength is that, to carry out the gluing operation successfully, it is essential to use dry timber with a moisture content which does not exceed 15 per cent. To obtain this degree of dryness economically, and with minimum reduction in strength during the kilning process, it has been found necessary to limit the thickness of laminations to 2 in.

Although there is an upper limit of 15 per cent to the moisture content permitted in the laminations, and usually a minimum of 7 per cent, it is preferable that when a moisture content of less than 15 per cent is known to exist in a particular building, that this is reached prior to the gluing process and maintained as far as possible in the member by wrapping until it is finally in use.

Manufacturing specifications frequently insist, as do the *Production Standards for Structural Glued Laminated Timber*,[3] that not only shall the laminations be within 3 per cent of the average equilibrium moisture content likely to be attained in service, up to a maximum of 15 per cent, but that adjacent laminations shall not vary by more than 3 per cent and all the laminations by not more than 5 per cent.

The effect of this requirement should be to ensure the manufacture of structural members of a uniform moisture content from dried timber of a predetermined moisture content, with the minimum of stresses being set up adjacent to the glue lines if and when equalization in moisture content takes place throughout the member. Also, because the eventual operating conditions should have been considered prior to manufacture, little damage is likely to occur to the glue lines of the member from diffusion of moisture when in service. On this basis, interior laminated members can be designed using working stresses applicable to approximately 18 per cent moisture content knowing that this figure should not be exceeded in service.

Working stresses for heavy solid timber sections cannot be based on a uniform moisture content because such sections are generally uneconomic to kiln dry, and if this were attempted it is likely that they would suffer considerable degrade in the process. Because of this, working stresses have in the past taken into account the lack of uniformity of moisture content and have allowed for the highest rather than the lowest moisture content throughout the section. Also, if a heavy section is used indoors then it will gradually dry, at the same time checking and splitting to a degree that must seriously affect its strength. On the other hand, if it is used out of doors then it is likely that the moisture content will always remain fairly high.

TABLE 1:—*The Average Increase (or Decrease) in Wood Strength Properties for a 1 per cent Decrease (or Increase) in Moisture Content*

| | |
|---|---|
| Static Bending: | |
| Fibre stress at proportional limit | 5 |
| Modulus of rupture | 4 |
| Modulus of elasticity | 2 |
| Work to proportional limit | 8 |
| Work to maximum load | 0·5 |
| Impact bending, height of drop causing complete failure | 0·5 |
| Compression parallel to grain: | |
| Fibre stress at proportional limit | 5 |
| Maximum crushing strength | 6 |
| Compression perpendicular to grain, fibre stress at proportional limit | 5·5 |
| Shear parallel to grain, maximum shearing strength | 3 |
| Tension perpendicular to grain, maximum tensile strength | 1·5 |
| Hardness: | |
| End | 4 |
| Side | 2·5 |

For laminated structures used indoors, the problems associated with degrade due to drying does not arise and higher working stresses can be based on the uniformly low moisture content of the timber used. As Table I shows there is a variation in strength properties for each 1 per cent increase or decrease in moisture and it should be possible to increase the working stresses for laminated construction to be used in dry conditions by an amount reflecting drying appropriate to each property. Because the various timber properties are differently affected by drying, the increases range from about 10 to 50 per cent.

Obviously glued laminated members used out of doors in damp or wet conditions will eventually assume an average equilibrium moisture content much higher than the 18 per cent moisture content considered appropriate for interior structures. Therefore, no higher working stresses are used than for sawn timber members used under similar conditions.

## Knot Frequency

The second factor controlling increased working stresses is based on knot frequency studies which have been carried out in the USA, Canada and this country, on laminated beams[4]. These studies have shown that, even with a random assembly of laminations, knots are unlikely to occur one above the other in a number of adjacent laminations. By selection and careful placing the knots can be well scattered and even greater strength obtained.

The effect of a knot on strength in laminated structures depends upon its size, location in the laminations and the position of the lamination in the cross-section of the member. In a laminated member a similar size knot to the one considered in the solid member can, even under the worst conditions, only penetrate to a maximum of 2 in, because this is the thickest lamination used.

When buying a parcel of timber, graded for commercial purposes, the manufacturer will find that the grading rules used have been based on general appearance and that in all probability no limits have been placed at all on slope of grain, and the size of knots permitted may have no relation to the width of the boards.

In the construction of a glulam member, designed to resist a bending load, it is possible to use high grade laminations in the outer portions, where their high strength can be most effectively employed, and lower grade laminations in the middle portion, where their lower strength is not likely to affect greatly the overall strength. Obviously, in this way, there is a great advantage to be gained by reselection, or regrading, of a commercial parcel into a number of stress grades so that the whole can be economically and correctly used.

Efficient and economical use of material may thus be attained by using layers of high and low strength laminations as mentioned above, the relatively small effect of low grade material occupying as much as the central three-fifths of the depth has been demonstrated in statistical studies of knot-effect.[4]

## Stress Grades

The use of two grades of timber in a glulam member is known as "combining grades" and the two grades are collectively referred to as a "combination grade."

It has been ascertained that, given four stress grades of timber, suitable for laminating, as many as seven different "combination grades" will satisfy a single working stress in bending. Though four grades have been mentioned, the strongest and generally the most expensive grade (90 per cent strength ratio* of timber free of all defects) is used to a lesser degree than the other three grades. This is probably due to the fact that, in a normal parcel of commercial timber, the percentage of the highest quality boards which will be found is likely to be low. Another reason is the rapid increase in strength of low grade laminations when used in quantity, as Table II shows, and for most laminated members only a few medium grade laminations may be necessary in the outer sections, the low grade laminations being used in the centre in sufficient quantity that they assume a much higher strength ratio than the initial grading would indicate. This increase similarly applies to the outside medium strength laminations.

Because of the increase of strength of the basic strength ratio with the increase in the number of laminations, the problem of limiting the effect of slope of grain is important.

Slope of grain, which has a strength reducing effect, is limited in grading to a maximum slope which gives a strength ratio as great or greater than the effect of the largest knot permitted by a particular grade. For instance, a 50 per cent strength ratio grade would require a slope of grain not steeper than 1 : 8, and a 90 per cent strength ratio not steeper than 1 : 20.

If advantage is to be taken of the increase in strength of low grade laminations when used in

* Strength ratio is the ratio of strength remaining after making allowance for the maximum effect of various defects to the strength of a non-defective piece of timber.

quantity, then it is considered unlikely that the original limitation of slope of grain permitted by the grade will be adequate for those used in the outer 10 per cent of the member and it is possible that much more severe limitations will be necessary.

This problem applies also to end joints which vary in efficiency with the slope of grain and the slope of the scarf. This means that an end joint having an effective strength ratio equal to a 50 per cent grade might prove unsuitable if the grade were used in the outer laminations of a member designed at a strength ratio of 90 per cent.

The biggest problem facing the industry is that of establishing a controlled guaranteed system of grading.

In both the North American countries grading bureaux exist which undertake grading inspection and train competent graders. No such body exists in this country, though the Timber Development Association has, in a small way, endeavoured to fill the gap.

From the information already presented, it will have been gathered that accurate and efficient stress grading of timber is no simple matter, but it is upon this that the safe combining of different grades of timber into high quality engineering structures rests. It is probably true to state that though timber is selected for use in glulam members, little stress grading is undertaken in accordance with accepted rules. This is mainly because no grading rules have been established for this medium and the cost of grading (about 10 per cent the cost of timber) is not at present in any way offset by the use of increased working stresses.

If higher stresses are eventually recommended in a revised issue of BS Code of Practice CP 112,[1] then the quality of workmanship and control in manufacture will, in all probability, require to be of a higher standard than at present exists.

## Adhesives

It should be obvious that if less timber is used to support a given load, the glue line area is also reduced and, therefore, the load carried per square inch of glue joint increased, perhaps substantially. The quality of adhesive, and glue line, which performs adequately under the working stresses laid down in the existing Code of Practice may not be of sufficiently high standard to handle greatly increased working stresses, and no doubt this will lead to a demand for a highly organized system of quality control and inspection, such as has been found necessary in USA and Canada, to back up the use of increased working stresses.

The Timber Development Association might well be able to assume the mantle of an inspecting authority, if only because most glulam manufacturers are members of the Association. From a practical standpoint it has already gained considerable experience in the inspection field, supervising the grading and selection of material, the full manufacturing processes and the erection of finished structures. It also has the laboratory facilities to back this experience.

Having dealt with the problems connected with timber, what is the position with the British Standard relating to structural adhesives? These, it is believed by many authorities, also call for considerable revision.

The two British Standards most concerned with structural adhesives are BS 1204, 1956, "Synthetic Resin (Phenolic and Aminoplastic) Adhesives for Structural Work in Wood,"[5] and BS 1444 (A), 1948, "Cold Setting Casein Glue for Wood,"[6] both of which were drafted several years ago when little consideration was given to the problems of gluing timber laminations together into members which could be weighed in tons.

Research has shown that the results obtained from a glue joint made with a particular species do not, in general, indicate how a different species will glue with the same adhesive. Furthermore, as far as may be judged the gluability of the various species within a particular genus, for example eucalyptus, may not always be determined by the results obtained from a single species within the genus.[7]

TABLE II:—*Strength Ratio, as Determined by Knots for Beams consisting of Laminations of a Single Grade and having not more than Two Maximum Size Knots, or Equivalent, within 6 in of any Cross-section.*[4]

| No. of laminations | Strength ratio for grades of laminations | | | |
|---|---|---|---|---|
| | 90 per cent | 75 per cent | 60 per cent | 50 per cent |
| 2 | 86 | 65 | 42 | 23 |
| 10 | 95 | 86 | 77 | 66 |
| 20 | 98 | 94 | 90 | 85 |
| 30 | 98 | 96 | 94 | 91 |
| 40 | 99 | 98 | 96 | 94 |
| 50 | 99 | 98 | 97 | 95 |

From such investigations it becomes clear that the use of a single species, beech (*Fagus Sylvatica*) in the British Standard test[5] to determine the behaviour of a particular adhesive with different species is likely to be misleading.

Furthermore, it is believed that for structural gluing the use of specially selected thin test specimens (6 in and 4½ in × ⅛ in) does not indicate the behaviour of glue lines in laminations which may be up to 2 in in thickness with knots up to 50 per cent of their face width with considerable areas of disturbed grain. The strength tests require that the average of six tests shall comply with a mean failing load so that if one test gives an exceptionally high result and the remainder fail to meet the failing load, but the failing load is complied with on average, then it is considered satisfactory.

For the gluing of structural members which have to be fully exposed to the weather or in places of high humidity a WBP (weather and boil proof) gap-filling adhesive is advocated.

WBP adhesives are defined as "adhesives that by systematic tests and by their record in service have proved highly resistant to weather, micro-organisms, cold and boiling water, steam and dry heat."[6]

To comply with the WBP specification, the test joint, again made with beech slips, has to be boiled in water for six hours, withstand a tension pull of 225 lb per sq. in and resist a micro-organism test. This is probably the test which is considered most impractical.

Not only is it highly improbable that a large structure weighing many hundredweights will ever be boiled but the temperatures used to cure the WBP adhesives rarely exceed 150° F and most frequently are very much below this figure, averaging 100° F. If this test is intended to indicate durability it is difficult to understand why the failing load prior to the boiling test is 450 lb per sq. in and after the test the failing load is only 225 lb per sq. in. Surely a reduction in strength of 50 per cent is hardly an indication of long term durability?

It is also difficult to relate this boiling test to, say, 50 years of durability, such as the engineer requires for the design of a long term structure.

Research into the durability of WBP structural adhesives has shown that, when used with oak (*Quercus*) delamination with some types becomes apparent after a very short period of exposure to the weather, though the adhesives comply fully with the BS 1204 WBP requirements and the glue line prior to exposure has maximum strength.[8]

With the insistence on a boiling test for WBP adhesives there is always a possibility that adhesives might be formulated with the test requirements in mind, so that the greatest durability is obtained at 212° F, but undefined durability at lower curing temperatures used in manufacture.

All adhesives age or tire, some faster than others, and if an engineer is anxious to ensure that the adhesive he has specified for use in a timber structure, intended to last for 25 to 50 years, is safe to use he may require the adhesive manufacturer to produce evidence of natural ageing. Evidence which he would be provided with, under the requirements of BS 1204, would state only that the adhesive, after storage at a temperature of 25° C and a relative humidity of 45 to 60 per cent for 12 months, had complied with the dry strength test. The evidence will not relate to the actual consignment of adhesive used but to the type and brand, though the formula for the brand might have been changed for better or for worse since the ageing test was originally carried out.

It certainly appears that a revision of the existing British Standards for structural adhesives is necessary which would take into account the actual species used as well as durability and moisture resistant qualities related to the actual manufacturing temperatures.

The new Canadian Standard 0122: 1959, "Specification for Glued-Laminated Softwood Structural Timber" (second edition)[9] calls for tests to be made on a number of block shear specimens taken from actual members made, and when a member for exterior exposure is manufactured, cyclic delamination tests on specimens also cut from the actual members. The cyclic delamination test is a prolonged accelerated artificial weathering test designed to find how the glue lines behave when the timber has water forced into it and then removed by alternating periods of pressure and vacuum. The important point is that the tests are related to actual manufacturing conditions, while the cyclic test is an attempt to reproduce actual service conditions.

Perhaps an additional test should also be introduced to assess the ability of adhesives to withstand the high temperatures which might be encountered during a fire. The high fire endurance properties of large timber sections are often extolled and recognized, but it would be disastrous for glued laminated members if it were found that certain adhesives did not possess similar qualities.

## Conclusions

To sum up on the problem of the use of higher stresses in the design and manufacture of glulam members, it appears that there is evidence to support the author's contentions and that the industry cannot really be economic without glulam members.

If glulam members are to be used then some body will have to be established to train graders and control their work, as is undertaken in North America, and a comprehensive inspection system inaugurated. The latter should be instituted without delay in order that quality control will exist in the industry by the time the existing Code of Practice is revised.

The present method of testing adhesives for structural work will probably need revising before higher working stresses are generally permitted and a greater amount of research organized to find what happens to glue lines in timber structures permanently under stress, especially when subjected to additional stresses induced by the natural hygroscopicity of timber.

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# Power and Elegance in Continental Cars

**New cars and engines from Italy and France display improved style and performance.**

*By Gordon Wilkins*

FOLLOWING the International Motor Show in Geneva, the writer has recently completed a tour of centres of the European motor industry. Improvement and perfection of existing models rather than revolutionary departures seem to characterise the current efforts of French and Italian designers.

### More Power for the Citroen DS 19

Although very advanced in appearance and in the use of hydraulics for the control of suspension, clutch, gear change and brake servo, the DS 19 Citroen has had to make do with a four-cylinder pushrod engine developed from

*Fig. 1 With increased compression ratio, the engine of the Citroen DS 19 now develops 83 bhp.*

that used for many years in the previous models. Compression ratio of the 1,971 cc engine has now been raised from 7·5 to 8·5 to 1 by new domed pistons with chromium plated upper rings, and the crankshaft now has a vibration damper at the rear end, while a Weber twin choke 24/32 ddc carburettor has been introduced instead of 24/30. The result is an increase in bhp from 74 to 84 without increase in revolutions, and maximum torque has gone up by 11 per cent to 109 lb-ft. The factory now claims a maximum speed of 93 mph. The DS 19 is shown in Fig. 1.

### Front Wheel Drive for French Small Cars

Preliminary details of the new small Citroen show it to be as bizarre in appearance as the famous 2CV although it is a faster more luxurious model. The outstanding feature is a rearward sloping rear window like that on the Ford Anglia but more exaggerated. It has four doors; those in front have sliding windows while those at the rear have winding windows and there is a big fresh air intake on the scuttle.

It is said to have much more performance than the homely little 2CV, which, whatever its merits in durability and economy is heartily disliked by other French motorists for holding up traffic on hills. Maximum speed of the new model called the Ami Six is said to be 60 mph, but it would be a considerable technical achievement to obtain fast acceleration and hill climbing on a full four-seater saloon propelled by a little flat twin air-cooled engine of only 600 cc.

Following the Citroen tradition, the car has front-wheel drive and appears to have all-independent suspension by coil springs at the centre of the chassis interconnected between front and rear to cut down pitching as on the 2CV. For its production, Citroen will presumably use the facilities at their vast new plant now under construction at Rennes and the first deliveries are promised before the summer.

Competition will be very keen between the Citroen and the new small car which Renault are expected to introduce later this year to replace the 15 year old 4CV which was the first French car to go into large-scale production after the war. Although both the 4CV and the Dauphine have rear engines, Renault are believed to be adopting a front engine and front wheel drive for the new car, which according to some reports will have a square utility body rather in the style of the Mini-Minor.

### Fuel Injection for the Peugeot 404

Early in 1962 Peugeot expect to be delivering the 404 saloon with fuel injection instead of a carburettor on its 1·6 litre 4-cylinder engine. The Peugeot 404 fuel-injection engine is shown in Fig. 2. The injection system, developed in collaboration with Kugelfischer Schafer AG, of Munich, uses a four-plunger pump injecting fuel into the inlet ports and driven from the timing gear. Installation was aided by the fact that the engine lies at an angle of 45° in the chassis. As this engine has hemispherical combustion chambers with inlet and exhausts on opposite sides, it was simple to mount the pump unit close to the air throttle.

Compression ratio has been raised from 7·2 to 8·5 to 1 on injection-equipped engines, and maximum power is raised to 85 bhp gross at 5,500 rpm—an increase of 12 bhp. Maximum torque is raised to 101 lb-ft at 2,800 rpm. Thanks to the higher volumetric efficiency obtained from the unobstructed inlet manifold and the leaner mixtures possible when equal distribution is assured to all cylinders, Peugeot claim specific fuel consumption is reduced to 180 grammes per bhp-hour. This development may herald the appearance of Peugeot models of a more sporting character than those at present.

### Facellia : Choice of Two Engine Versions

With the first export deliveries of the 1·6 litre Facellia, shown in Fig. 3, Facel Vega offer three choices of coachwork, all finished in their usual luxurious style with two versions of the 4 cylinder twin-cam engine. Bodies are two-seater coupé and convertible and a so-called four-seater coupé, which has two rear seats suitable for small children and a smaller luggage trunk. The normal engine, now known as the F-2, has twin-choke Solex down-draught carburettor and gives 113 bhp at 5,400 rpm from 1,648 cc on a compression ratio of 9·4 to 1. This car now has vacuum servo assistance for the Dunlop disc brakes used on all four wheels.

But for those who want still more performance there is now a highly tuned engine, the F-2-S with two twin-choke Weber carburettors. Using a compression of 9·6 to 1 it is said to deliver 123 bhp at 6,400 rpm. The twin carburettor inlet manifold does not permit use of the vacuum servo for the brakes on this model; otherwise the chassis, with tubular frame, independent front suspension by coil springs and rigid rear axle with coil springs is similar to that of the F-2, except that the wheels are in light alloy. For this model there is an additional axle ratio of 3·9 to 1 besides the normal choice of 4·10, 4·16.

According to the factory a maximum speed of 120 mph has been obtained with the F-2-S, using the axle ratio of 3·9 to 1. However, neither its engine size (just outside the international class limit) nor its luxurious but heavy bodywork fit the Facellia for competition motoring.

### Short Chassis Zagato Appia

Lancia have produced a short-chassis version of their Appia to receive the light weight sports coupé bodywork by Zagato. Wheelbase is reduced by 5½ in to 92½ in, and the weight goes down to 1,650 lb, a reduction of 132 lb. The result should be a gain in both performance and in handling qualities. With the little 1,090 cc narrow-V engine developing 59 bhp, the new coupé is said to reach 100 mph. A still lighter model intended for competition work with weight cut to 1,560 lb is promised for the early summer, but the normal version will sell to youngsters with money who want a sporting car rather than a competition machine.

### Ferrari Superamerica with Improved Coachwork

Pinin Farina has made several changes in the coachwork he produces for Ferrari's most powerful car, the 3·9-litre V-12 393 bhp Superamerica. As originaly exhibited at the Turin Show last year, the coupé body had disappearing headlamps swinging down in the front panel. But this is now forbidden by Italian law, so a new front end has been designed with the head lamps conventionally mounted in the front wings. They are covered by transparent plastic fairings for export. The tail of the car has been shortened and the side treatment modified to suit the new wing line.

There is also a new hard top for the Pinin Farina convertible. Rear quarter windows line up with the winding windows in the doors to give a long expanse of clear vision at the sides. The new Italian code stipulates a minimum projection angle for headlamp beams and many headlamps recessed behind plastic fairings cannot comply. There seems to be some doubt as to whether the E-Type Jaguar can conform.

The short-chassis Farrari 250 GT Berlinetta body by Scaglietti has been further improved with a lower bonnet line and is now delivered in two versions, one panelled in steel for normal road use and one with aluminium with more highly developed engine for competitions. The competition engine gives 288 bhp.

*Fig. 2 (left) The Peugeot 404 fuel-injection engine has a higher compression ratio than the carburettor version and develops 85 bhp as against 73 bhp.*

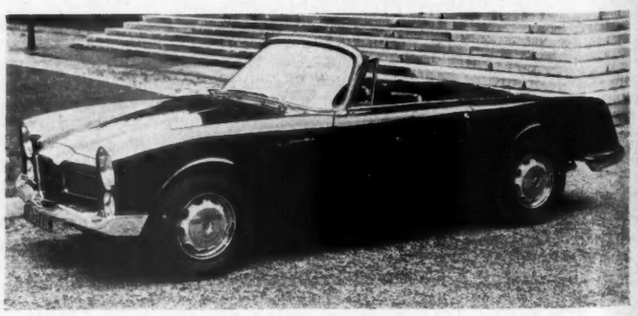


*Fig. 3 (right) The Facel-Vega Facellia, shown here in the F-2 cabriolet version with two to three places, is now made with a choice of three coachwork styles and two engines.*

# Human Element

## New Era Coming in Car Industry

ONE of the characteristics of disputes in the motor industry in recent years has been the way strikes have broken out almost before the men at the top, either of the management or the unions, have known that the particular grievance was again giving trouble.

For this reason one of the most promising elements in the statement, signed by the representatives of the industry's employers and unions last week, is that which says that full time union officials and company representatives should be adequate in number, quality and training to cope effectively with the problems that come up. And equally, that they should have the power either to reach a conclusion or to pass the subject up to the next stage in the machinery of negotiation.

The document itself cannot be more important than the attitude taken by the management and the unions, now that the talks under the chairmanship of Mr. John Hare, the Minister of Labour, are over. It is not possible to be certain how the industrial climate of the motor business will develop.

What is clear is that strong divergences of opinion still exist. At the conclusion of the meetings, Mr. Geoffrey Rootes, spokesman for the employers, said that that part of the statement referred to here meant that both sides would re-examine their delegation of authority. Mr. Jim Matthews, President of the Confederation of Shipbuilding and Engineering Unions, said, on this point, that the union officials already have sufficient powers.

One of the best chances for advance—and also for disagreement—in good relations and in productivity is the coming review by the employers of their methods of selection and training of supervisors and by the unions of their arrangements for the training of shop stewards. The unions are also to consider the suggestions put forward by the employers for shop steward training to be carried on at technical colleges or extramural departments of universities. The offer of paid leave for shop stewards for this purpose has been made by the managements. The unions' request for certain agreed facilities for the election of shop stewards is to be considered by the employers.

## Bank Credit for 600 Manual Workers

Six hundred of Stewart and Lloyds' manual workers at the Corby, Northants, iron and steel works, are to be paid at their own request by transfer of credit to a bank.

Since the wages of the 10,000 workers are handled by a LEO III computer, the bank transfer for the 600 presents no difficulty. All that happens is that an extra card will be punched as the payslip is printed. And since the pay roll has increased in size by 20 per cent since the beginning of its transfer to the computer the operation is making a profit.

Mr. R. M. Johnson, a member of Stewarts and Lloyds, speaking at a recent data processing conference held in London by the Institute of Office Management, explained that the computer also simplified the operation of the state pension scheme, which by manual methods would be a complex process.

A substantial saving in labour and time is obtained at Corby by the practice of paying workers to the nearest ten shillings above the amount due. The computer automatically adjusts their wages in the following weeks.

## Railway Engineers' Pay under Dr. Beeching?

The Engineers' Guild, which has numerous members employed by the British Transport Commission, has welcomed the appointment of Dr. Beeching to head the railway board, expressing the hope that the appointment implies the Government's recognition that restoration of economic viability to the railways depends first upon the "technical success of the modernization plan."

The Guild recalls that for more than six years it has been pressing on the British Transport Commission that to get the best talent it must pay the market rate, a principle now acknowledged in the House of Commons by the Minister of Transport.

Over this period the Guild has repeatedly pointed out the disparity between BTC salaries to engineers and those received by the profession in other fields of employment. The Commission has, for all the Guild's efforts, refused to accept the problem as one to be dealt with out of the context of general wage and salary increases.

The result of this has been that shortage of staff has limited the implementation of the modernization plan and brought on a rapid departure of staff.

The Select Committee on Nationalized Industries themselves noted that for certain qualified staff the top salaries in the middle range were some 15 per cent below the average received elsewhere.

Taking up Mr. Marples recognition that the Guillebaud principle of comparison with earnings in outside employment cannot be denied to managerial staff, the Guild repeats its submission to the BTC of a year ago—that there should be an independent inquiry into the salaries of BTC engineering staff. The recent increase of 10 per cent to all senior staff does not diminish the conviction of the Guild's members that such an inquiry is now even more necessary.

## Drop Forging Industry Committee Reappointed

The joint standing committee on health, safety and welfare in the drop forging industry has been reappointed by the Minister of Labour under the Factories Act, 1939. The committee has been appointed for three years to advise the Minister.

Reappointment of the committee followed consultations with the Amalgamated Engineering Union, the Associated Blacksmiths', Forge and Smithy Society, the Engineering Employers Federation, the Iron and Steel Trades Confederation, the National Association of Drop Forgers and the Transport and General Workers Union. All these organizations have representatives on the committee and there is one from Garringtons, one of the major firms in the industry.

The new body replaces and is to continue the work of the joint standing committee for the drop forging industry set up by the Chief Inspector of Factories in 1954.

## Egocentric Behaviour in Conference Trotters

Since there are some 1,200 international congresses held every year, and eight or ten times as many national congresses, it follows that sooner or later there was bound to be a conference on conference holding.

In practice the first conference of international associations and specialists, arranged by the Union of International Associations was held in Düsseldorf in 1959, followed a year ago by the Second Congress of International Congress Organizers and Technicians, at Lausanne.

Now, writing in Volume One of *International Congress Science*, M. J. Milhaud, who is the Délégué Général of the International Committee of Scientific Management, has identified some of the problems facing the leaders of international organizations.

The aims of those taking part have come in for special consideration from the Council of International Organizations for Medical Science, whose publication on organizing international meetings says: "There is one type of aim which is the nightmare of all congress organizers; it is that of the participant who has a passion for travelling and, in some countries, can transfer the cost of his travel to professional expenses if he goes to a conference. A conference may also be used as a plausible excuse to an employer or to silence one's own conscience.

"The congress participant whose sole desire is to use the congress as a sounding board for a new discovery, or simply for showing off, can also be a cause of real trouble. It often happens that participants in official positions can only get their travelling expenses paid if they give a paper at the congress. Once this has been done, they often take no further interest in the remainder of the proceedings."

The same organization concludes that all these motives may generate a certain amount of egocentric behaviour among participants and so convince the organizers that the objectives of the majority of the delegates are diametrically opposed to their own.

## Exports Studies at Sundridge Park

A series of courses in export studies are to be held for senior management starting in June at the Sundridge Park Management Centre, Kent. The intention is to give intensive training to executives at a high level in the financial and economic background and in export problems and procedures.

The Sundridge Park Management Centre, set up under the auspices of Personnel Administration, management consultants, six years ago, have planned the courses in consultation with an advisory panel set up by the Federation of British Industries. Courses will last for either one or three weeks. Case study work and discussion groups will occupy much of the manager-students' time.

From Fixing Selling Price to Training and Development of the Export Team, the principles and methods discussed will be applicable to companies of any size, and to products varying from cosmetics to industrial furnaces.

## From the Labour Minister to the Factory Bench

A valuable collection of facts and figures on wages, hours of work and holidays, the subjects that form the basis of most collective bargaining in industry, appears in the last, but not least important, part of the Ministry of Labour's new publication, the *Industrial Relations Handbook* (HMSO, 5*s* 6*d*).

One of industry's best sellers, the handbook was first produced for the Ministry of Labour staff. On the theory that it might have wider public interest, a first edition was published in 1944 and a second nine years later.

First place is given to the development of joint negotiation between employers and employees. Industrial relations in Britain have grown principally through voluntary organizations, legislation has tended to take a secondary, though influential, place; both are adequately dealt with here.

The handbook's explanation of joint negotiating machinery in private concerns, the nationalized industries and in the public services is given in greater detail in this edition. There is also an informative account of industrial relations organization of individual factories and work places.

The Minister of Labour's part in industrial affairs, and the legislative base from which he works, is described in the second part of the book, in which disputes concilliation, arbitration and enforcement of terms and conditions of employment and of fair wages are discussed.

## English Electric 1961 Scholarships

The level of examination results achieved by the candidates for this year's university scholarships and exhibitions awarded by English Electric is reported by the company to have been very high. The selection board for the 1961 awards included representatives from two universities in addition to senior members of the group's personnel services.

The 15 scholarships, each worth £450 a year and to be held at a United Kingdom university, were awarded to boys from:

George Watson's College, Edinburgh
Whitgift, Croydon
Colston's Boys School, Bristol
Mill Hill
Trent College, Nottingham
Stratford County GS, Cranbrook
Alleyne's GS, Stevenage
Kelvinside Academy, Glasgow
Beaumont College
Bablake School, Coventry
Clifton College
William Ellis GS
Harrow County
Watford GS

Five exhibitions worth up to £200 each were awarded to boys from: Bangor Grammar School, Co. Down, Barry County Grammar School, King Edward VI, Stafford, Gresham's, Holt, and Adam's Grammar School, Newport.

# The Versatile Diesel Continues to Thrive

**Many uses are found for diesel engines. Some recent applications are described. Increasing acceptance of smaller sizes and air cooling is noticeable.**

WHEN it comes to range of application and variation in size, the diesel engine stands out ahead of all other internal combustion engines. To illustrate the present use of this flexible power source a number of recent applications are described below.

Several trends are noticeable when applications are surveyed on a world scale. For marine applications, for example, there is the concurrent development of very small air-cooled engines for pleasure craft and the production of large water-cooled installations of up to 25,000 bhp for large tankers. Most work on small-size diesels has been carried out in Europe, but an American firm is developing a 150 cc unit and interest in the US in such small sizes is increasing. The production of diesels of increasing size has been a world-wide trend, following the increase in tanker sizes. Mitsubishi Nagasaki, for example, offer engines up to 18,000 bhp; Doxford are offering their new range in sizes up to 18,000 bhp, too; Harland and Wolff are prepared to offer 10 cyclinder engines developing 21,000 bhp; and Burmeister and Wain are extending their range to a 12 cylinder engine developing 25,000 bhp. Fiat are also well advanced with an engine of the same magnitude.

In the medium-size range of diesels, differing national trends regarding the application of air-cooled and water-cooled diesels are evident. In agriculture and earth moving machinery, for example, much greater use of air-cooled engines is made in Germany than in the United States, with Britain coming in between but favouring liquid cooling. A trend in both countries towards air-cooling is however noticeable.

## Marine Engines

Before the Second World War, 28 per cent of world shipping tonnage was driven by diesel. By 1954 this percentage had risen to 49 per cent.

Starting at the small end of the marine range, a diesel outboard motor of 9¼ hp at 3,500 rpm is being developed by American Marc Incorporated. An opposed-piston two-stroke engine is used, with the cylinder axis horizontal and the crankshaft vertical. The lower exhaust temperatures compared with petrol engines enable the use of a much smaller water pump and consequently a more streamlined contour of the propeller skeg.

*British Waterways are replacing the engines in narrow boats with twin-cylinder air-cooled diesels.*

Changeover to air cooling in the small size engines can be instanced in two types of British craft. The 100 ton tank barge Brendor built in 1934 has been re-engined recently. The water-cooled 75 hp two-cylinder Deutz was replaced in this instance by a six-cylinder air-cooled Deutz type SF6C 714, developing 85 hp at 1,500 rpm. The removal of the water-cooling equipment simplifies the engine room installation very much.

The South Eastern Division of British Waterways, who operate the largest fleet of narrow boats on the canals, are carrying out an extensive conversion from water-cooled engines to air-cooled. In a three year scheme, 90 pairs of barges will be fitted with PD2M twin-cylinder vertical diesels produced by Petters Limited.

As engine sizes get larger, however, the air-cooled diesel is no longer practicable. For river craft on the Danube, for example, Skoda produce water-cooled engines from 200 to 1,000 bhp. Czechoslovak river craft built for export include one equipped with diesel-electric propulsion using two Skoda 61275 six-cylinder diesels (400 hp at 550 rpm) driving 273 kW Mez dc generators. The propeller motors are rated at 250 kW at 240 rpm. The building of a new three-deck craft using three such engines with a reversing reduction gearbox is in the development stage.

In river shipping it is especially important to reduce engine weight and size, because of the low permitted draught of such ships. Supercharging has been used by Skoda to increase the output of the four-stroke engines by 50 to 80 per cent. In addition weight economies have been effected in various component parts of the engines. The double-piston pump for cooling and sludge water, for example, has been replaced by a centrifugal design and a 50 per cent weight saving in the component achieved.

The use of diesel-electric and diesel-mechanical drives on the same vessel is exemplified by the US non-propelling cutter-dredger Alaska, which has a displacement of 2,100 tons. It cuts a swathe 125-350 ft wide from 9 to 50 ft below the water. The main pump has a 33 in diameter suction and 27 in diameter discharge, and is driven through clutches and a reduction gear by two ganged diesels of 2,800 bhp. These are General Motors type 16-498.

Another diesel of the same type is used to drive three General Electric generators which supply the following equipment: two 600 hp electric motors, which drive the cutter head through a reduction gear, a 250 hp motor for the ladder, a 150 hp motor for the spuds, and a 200 hp slewing winch. The 16-498 is a uniflow scavenging turbocharged type.

A new design of the famous Doxford marine engine is being tested in the mv Montana. It is a type 67PT6, a 6-cylinder engine rated at 10,000 bhp, and is hoped that it will be a worthy successor to the company's earlier engine, of which there are more than 1,500 at sea propelling motor ships.

The original engine (1934) had been first rated at 80 lb per sq. in mean indicated pressure, and this had been increased over the years to 88 lb per sq. in with normal aspiration and to 115 lb per sq. in with turbocharging. It was realised that the new engine would require to have a life of 20 to 25 years and that during this period both speeds and mean pressures would probably increase. The 1934 engine had increased in speed from 100 to 115 rpm and it was thought that during the next 20 years speeds would probably increase to 130-135 rpm. Similarly, mean pressures would increase, particularly so with turbocharging; so the new engine was designed for a rotary speed of 135 rpm and a mean effective pressure of 135 lb per sq. in with the possibility of this rising to 150 lb per sq. in in the next decade. The maximum pressure that would result from such mean effective pressures would probably be in the region of 1,000 lb per sq. in.

Representative of the larger range of diesel engines now being produced is the 23,000 bhp, at 115 rpm, unit built by Gotaverken in Sweden for a 40,000 ton tanker. The engine is a 10-cylinder two-stroke single-acting design, turbocharged with a constant pressure system. The makers claim that a 12-cylinder version of the engine would develop 25,200 bhp and would be suitable for a single-screw installation in a tanker of 65,000 tons. A twin-screw installation could cater for tanker weights up to 100,000 tons.

## Stationary Engines

The very large engines developed for marine use are not met with on land. For example, the largest diesel generator station in Europe, while having an installed power of 28,200 hp, uses four separate engines to achieve this. The station at Fribourg, Switzerland, has recently been modernized and its capacity increased to the figure quoted. It provides an example of contemporary power station practice.

In this case, the diesel power is used to compensate for fluctuations in power yield of hydroelectric plant. Originally the plant had one Sulzer diesel, installed in 1931. This was a two-stroke developing 10,800 bhp at 150 rpm. It has been overhauled and modernized by substitution of solid injection for air injection, by cooling the pistons with oil instead of water, and by installing a closed-circuit water system for cooling the cylinders. In addition, three new sets using diesels developing 5,280 bhp at 250 rpm have been installed. These are Sulzer type 12TAF48 and are single-acting 12-cylinder two-strokes with trunk pistons and turbochargers. Each drives a 4,650 kVA generator.

Features in the recent development of stationary diesel engines have been their adaptation for severe climates and provision of remote control.

A particularly severe environment for diesels is provided by the oil pipeline pumping stations in the Sahara. One, a temporary station sheltered only by a roof, subjects the equipment to periodic immersion in sand. The engine is an Alco 16-cylinder diesel developing 2,083 bhp at 120° F. Air filter arrangements remove up to 500 lb of sand per day from the engine intake; the sand is blown away continuously from the filter equipment and no operator is needed. Such a capacity is called for as the operating staff leave the engine during a sandstorm and take cover, while the engine runs on. After a lengthy storm workmen have to shovel sand away from the engine.

An example of remote control of a diesel installation is provided by equipment recently installed at about the mid point of the 233 mile pipeline between Seymour, Indiana, and Chicago. This automatic booster station increases the capacity of the 14 in pipeline from 45,000 bbl per day to 65,000 bbl per day. The diesel was chosen as it could be switched on or off as required, to meet the seasonal variation in flow of oil to the city. An electric installation would have incurred connected-load charges for a large electric motor, even when it was idle.

An eight cylinder four-stroke Nordberg diesel is installed, developing 1,750 bhp at 514 rpm. It drives a six-stage centrifugal pump at 3,600 rpm. Remote control of the set is carried out over a leased wire circuit. For control purposes a forced-sequence set of instructions is used, that is, each stage of the starting up process initiates the next. This system was chosen in preference to a programmed or timed sequence, owing to the variations in operating parameters that occur during the seasons.

The initial "start-up" instruction starts the lubricating oil pump, the crankcase vacuum pump, and the priming pump for the gearbox. These all run up together. As the gearbox lubricating oil pressure builds up, it initiates the

starting of the engine oil priming pump. In turn, the engine oil pressure starts the fuel oil booster pump and also the pump for the jacket water. When the jacket water pressure reaches a certain value it starts the water pump for the radiator. Finally, the rise in radiator pressure leads to the admission of starting air to the engine. From the original start-up signal to idling speed takes about 4 minutes.

At the very small end of the engine capacity range, vigorous development has been under way on engines for driving small generators, spraying equipment, compressors, and farming equipment. A two-stroke air-cooled unit, Slavia type 1D80, is produced in Czechoslovakia for such purposes. It is a two-stroke vertical unit with scavenging from the crankcase, having a rated output of 6·5 hp at 2,200 rpm. In Britain, Villiers Engineering produce the type D270, developing 4 bhp at 3,000 rpm. This is a four-stroke air-cooled engine weighing only 160 lb.

In the United States, American Marc are developing miniature diesels of 150 to 330 cc for powering motor generator sets. Opposed piston engines with aluminium cylinder blocks are used and weights of 65 lb for a 500 W set and 120 lb for a 2·5 kW set are quoted.

## Vehicle Diesels

The small diesel has found growing acceptance for vehicle use in Britain and Europe and is beginning to make its appearance in this role in the United States. In Germany, much greater use is made of air-cooled diesels, while Britain still favours water-cooled diesels for transport use. Major increases in power output of present sizes is only likely to result from the use of supercharging, but progress in this matter is fairly slow.

A recent application of diesels to the smaller type of cross-country vehicle is in the Willys Jeep. A version powered by a Perkins four-cylinder 192 engine is now available. The engine develops 62 hp at 3,000 rpm and has capacity of 3·15 litres. It uses the Perkins combustion system with twin-hole injectors and is fitted with a compact distributor-type fuel pump incorporating a hydraulic governor. The engine is available in the CJ-5 and CJ-6 export models of the Jeep Universal and the Jeep 1 ton pick-up truck.

An unusual arrangement for diesel engines is found in a prototype single-decker bus produced by Fabrique Nationale d'Armes de Guerre, Belgium. Two Perkins P6 four-stroke units are mounted transversely in a rear compartment. They are in line, with the flywheel ends pointing to the same side. The engines develop 78 bhp at 2,400 rpm and both transmit their power by way of Fluidrive hydraulic couplings to a central gearbox. Double flexible mounting is used and the whole arrangement is designed to cut down engine vibration and the transmission of this vibration to the bus bodywork.

An example of the air-cooled philosophy is provided by the Saturn II single-decker bus made by Klockner-Hümboldt-Deutz for urban services with frequent stops. It has a capacity of 32 seated passengers and 70 standing. The engine is a Deutz F6L614, which is a six-cylinder air-cooled unit developing 132 bhp at 2,300 rpm. It is mounted at the rear (access to the fuel injection equipment is obtained by lifting the rear passenger seat) and is geared to give the bus a maximum speed of 50 mph. Reports describe engine noise as unobtrusive.

A rear-engined bus is produced by Leyland Motors Limited. Called the Lion, the chassis is designed for a 34 ft body and has a frame of double thickness and high ground clearance, making it particularly suitable for operation over rough roads. The engine fitted is the Leyland Power-Plus P.650 diesel, which develops 200 hp at 2,200 rpm.

A Twin-Disc hydraulic torque converter is used in the 250 ton railway crane used by Quebec Cartier Mining Company for re-railing locomotives, etc. A Rolls Royce C6SFL six-cylinder vertical liquid-cooled supercharged engine delivers 255 bhp at 1,800 rpm through the torque converter to an epicyclic reversing gear box with enclosed spiral bevel gears and longitudinal cardan shafts to the crane machinery.

At a recent meeting of the Diesel Engineers and Users Association, Mr. R. G. Hill of British Twin Disc Limited estimated that 25 to 30 models of wheeled earth-moving machines are produced in Britain with torque converter transmissions as standard, and so also are about six tracked-excavators, 15 to 20 types of industrial shunting locomotives, and two large crawler tractors. Various models of fork-lift trucks have been available with torque converter transmission as standard for a long time. With the exception of a comparative handful of industrial towing vehicles, however, the British wheeled tractor industry still sticks to the mechanical gearbox.

Torque converters are usually fitted to the vertical British United Traction engines that are being fitted into an increasing number of shunting and transfer-type locomotives, although mechanical and electric transmissions are also employed.

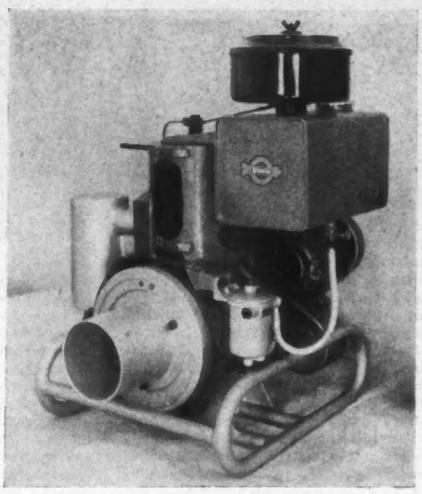
A milestone in the progress of dieselisation has been reached by Vickers-Armstrongs (Engineers) Limited with the production of their 300th Sulzer engine for British railways. The particular engine is an inter-cooled version of the 12LDA28 design being supplied to power Type 4 locomotives under construction at Derby and Crewe. The total of 300 is made up of 196 six-cylinder, 49 eight-cylinder, and 55 12-cylinder engines.

In the United States there has recently been criticism of lack of promised economies in the widespread operation of diesel trains there. At present two leading railroads in the Western US are experimenting with diesel-hydraulic locomotives produced by Krauss-Maffei of West-Germany. It is hoped that these will need little maintenance.

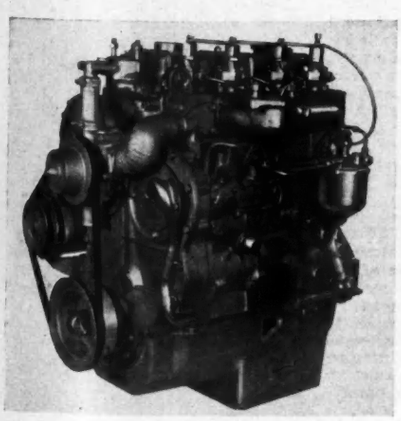
In Czechoslovakia widespread standardization of railway traction engines has been carried out and only three series of engines are produced, generally of the four-stroke type. These include the air-cooled Tatra engines with outputs up to 300 hp, the water-cooled 170 CKD engines for outputs between 300 and 1,000 hp, and water-cooled series 310 CKD engines for outputs of 750 hp and higher. For the small engines hydraulic transmission have shown a number of favourable characteristics and development of this type of transmission for higher power outputs is under way.

The four-stroke air-cooled Tatra engines are a development of road vehicle engines and are therefore of low specific weight and small size. A mechanical reduction box is used. The ease with which the cylinders can be stripped has also been found very useful. In all, the advantages have outweighed the increase in noise output of these engines (which are small enough to fit under the floor of the railcar, with adequate noise insulation). An air-cooled twelve-cylinder engine with a cylinder diameter of 120 mm and a stroke of 130 mm is in the development stage.

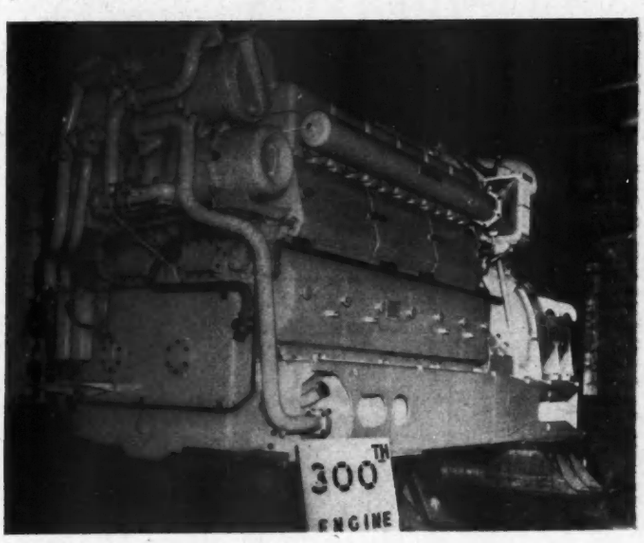
A similar stroke-bore ratio is used in the new Henschel series 1416 engines developed for that company's medium-weight locomotives. Built on unit-construction principles, the engines have a 155 mm stroke and 135 mm bore. Operating speed is 1,800 rpm, giving a piston speed of 9·3 m per sec, which is not excessive—service life should not be appreciably reduced. The result is a compact engine with an output speed suitable for hydraulic or electric transmission.



*Typical of the small general purpose diesel is this air-cooled two-stroke from Czechoslovakia.*



*(Left) Now available in Jeeps—a four cylinder water-cooled diesel.*




*(Right) A 12 cylinder diesel for British Railways, of inter-cooled design, and developing 2,500 h.p*

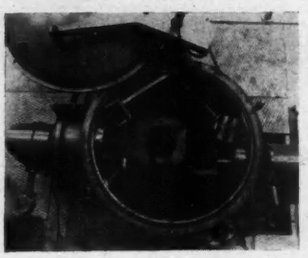
## INDUCTION FURNACE

### Range of Coil Sizes

THE MELTING capacity of an induction furnace can now be altered by using a range of interchangeable coils.

At present there are available three coils with nominal melting capacities of 28, 56 and 100 lb, all of which are interchangeable in the one furnace. The largest is shown in the illustration. The assembly lip tilts for pouring from a rotating coaxial seal carrying the power and water supplies to the coil. The furnace assembly is contained within a vertical water cooled vacuum chamber which incorporates charge addition mechanisms, immersion pyrometers, a bridge breaking mechanism, internal light and a support platform for the ingot mould. The chamber interior is viewed through a window fitted with a wiper and radiation shield attachment which keeps the window substantially free of the metal deposits which otherwise would obstruct the view by making the window opaque.

The charging mechanisms enable one-third of the bulk charge and a random



choice of six alloying additions to be added to the melt without breaking the vacuum. Accurate temperature measurement up to 1,800° C is obtained by means of two immersion pyrometers. The lid lift and slew mechanism is hydraulically operated by a hand pump on the furnace platform. This is now a standard fitting on the furnaces, which obviates the need for an overhead hoist for lifting the lid.

The standard furnace is fitted with a high capacity vapour booster pump designed for processes where large quanties of gas are evolved and low pressures are required in the minimum time. *Edwards High Vacuum Limited, Manor Royal, Crawley, Sussex.*

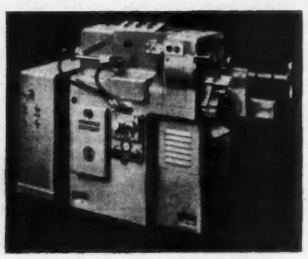
## POLYGON SHAPING MACHINE

### Fully or Semi-automatic

SQUARES, hexagons and octagons can be formed on the Tornomat 2 polygonal turning machine.

The component is held stationary and is rigidly located. It is machined by carbide-tipped blades on the cutter head which rotates at twice the speed of the rotor. The machined faces of the component correspond to the flat sections of an ellipse. To produce octagonal profiles, four cutter blades are required, for hexagons three, and for squares two, that is one blade for two parallel flats.

The capacity of the machine is, for hexagons from $\frac{1}{8}$ to $1\frac{7}{16}$ in across flats and for squares from $\frac{1}{8}$ in to $\frac{1}{16}$ in. Maximum turned length is $1\frac{9}{16}$ in. The hydraulic feed is infinitely variable from zero to 0·019 in per rev and the travel of the rapid traverse is $1\frac{7}{16}$ in. Indexing time is 1 second. The three rotor speeds are 250, 255, and 450 rpm, and the speeds of the high speed drilling spindle are 2,250, 3,200, and 4,050 rpm. The motor for the rotor drive takes 2·2 kW and for the hydraulic drive



1·5 kW. Floor space is $26\frac{1}{2}$ in by $60\frac{1}{2}$ in and the overall height is 48 in.

All rotating or sliding parts are totally enclosed. The work locating fixture is carried by the indexing head which is shaped as a truncated cone and is pressed into its seat during operation by both the hydraulic pressure and the cutting force ensuring a tight fit. The rotor is driven by a flat belt with change pulleys to give the speeds. For fully automatic operation the controls are actuated by the feed motion; for semi-automatic, the operator controls the electro-hydraulic system by two push buttons. *Hahn and Kolb Great Britain Limited, 243-245 Horn Lane, London, W3.*

## FREQUENCY AND CAPACITY METER

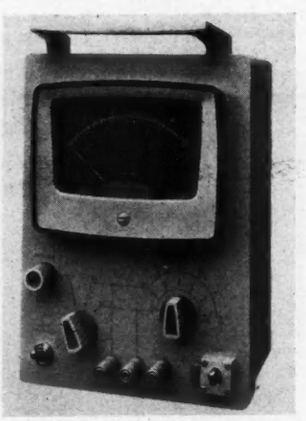
### Battery Powered

PORTABLE and battery powered the frequency-capacity meter model MM1009 will give direct readings of frequency and capacity.

The frequency range is from 0 to 100 c/s and from 0 to 100 kc/s and capacitance from 0 to 1,000 pF and from 0 to 0·3 $\mu$F. As a frequency meter it has a $\pm$ 3 per cent measuring accuracy on 5 ranges up to 10 kc/s and $\pm$ 5 per cent on the two ranges above. These accuracies hold for a 2 to 1 spread in mark/space ratio. The input signal (which may be from 100 mV to 150 V rms amplitude) is limited and fed into a pulse counting type integrating circuit. With a suitable input transducer the instrument can be adapted for tachometry.

As a capacity meter the coverage is in six ranges with a $\pm$ 2 per cent accuracy maintained over the battery range from 12 V to 8 V. The unknown capacitor is compared with the internal standard by substitution in the integrator circuit. The range can be extended to 1·0 $\mu$F.

The meter is light in weight and uses



semiconductor devices throughout; power is provided by eight leakproof U2 cells or equivalent, giving a useful operating life of three months. Overall dimensions are $6\frac{1}{4}$ in by $9\frac{3}{8}$ in by $5\frac{1}{2}$ in and weight 6 lb. *Solartron Laboratory Instruments Limited, Cox Lane, Chessington, Surrey.*

## DETACHABLE DUMPER

### Up to 10 Tons Capacity

THE Morewear Goose is a detachable two-wheel dumper for use with a tractor or tractor shovel.

A quick release connection to the tractor is provided by a ball and socket unit, the ball of which, mounted on the strengthened gearcase of the tractor, is of 3 in diameter. The cup is a forging on the neck of the dumper and connection is normally maintained by the weight alone. A pin is fitted as an additional safety device to prevent lifting under unusual conditions. The coupling has been successfully tested at loads up to 60 tons; the normal working load is under 10 tons.

A telescopic hydraulic jack operated by a hand pump is built into the base of the goose neck, which takes the weight when the dumper is to be uncoupled and lifts the socket clear of the ball. Coupling-up is equally straightforward, the jack being retracted to let the socket rest on the ball. The dumper can be steadied during loading by lowering two steadies bolted to the main frame.

The goose neck allows over 100° of articulation to be obtained, giving great manoeuvrability.

The dumper body is designed to hold 5 to 7 cu. yd (8 to 10 tons). A watertight tailboard can be fitted. The tipping gear is operated by a low pressure ram supplied from the tractor hydraulic system. The ram operates on the centre of the lifting arm plates and converts the backward thrust to a true upward lift. A 60° tip is obtained. By using a front shovel on the tractor a self-contained loading and tipping unit is obtained. *Mackay Industrial Equipment Limited, Faggs Road, Feltham Middlesex.*

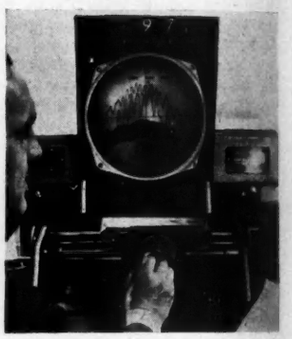
## TRACE READER

### Voltage Output Signal

THE THORNTON trace reader produces a voltage output proportional to the trace deflection.

The record rests on a table that is movable by two leadscrews along the X and Y axes. A small region of the chart around the lens axis is magnified and back-projected on a viewing screen which has on it two fixed intersecting diameters parallel to the table motions.

By moving the table so that the image of any point of the trace line coincides with the intersection of the viewer lines, each coordinate of that point is converted to a voltage between the sliders of a pair of multiturn potentiometers connected in parallel. One is geared to the respective leadscrew and the other is manually adjustable to permit any point to be made the origin of coordinates. Without disturbing the origin the coordinate scales may be fitted independently to any linear chart calibration by manually adjusting the voltage across any pair of potentiometers. The X and Y coordinate voltage,



selected by a switch, is displayed on a digital voltmeter with an accuracy corresponding to one or two thousandths of an inch on the record trace.

The X and Y table motions are 7·5 and 4·75 in respectively and the projected area of the trace is 2 in diameter. The instrument has been designed for inkless recordings but will handle other types if there is a white backing. *Shell International Petroleum Company Limited, No. 1 Kingsway, London, WC2.*

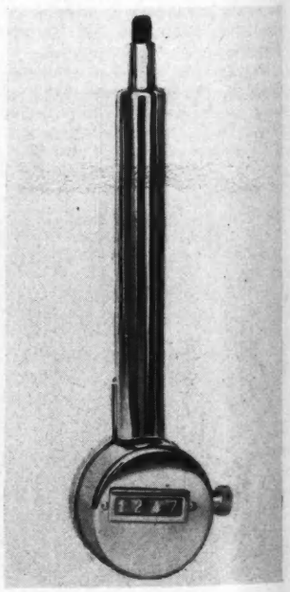
## MARKING COUNTER

### For Stock Recording

STOCK can be marked and counted in a single movement by the mark counter now being produced.

It is a sturdily constructed tool which is chromium plated; at one end it has a counter and at the other a marking pen. Each time the pen is pressed on a surface to mark it, the counter is advanced one unit. Thus not only is the item marked off but also a running total is kept without any doubt as to whether it has been noted on the sheet. The counter will also give a check on the paper record.

The whole device weighs only 7 oz. It is supplied with a set of five different coloured pens for identifying items or indicating dates, and a reserve of ink. Pen changing takes only a few seconds. The ink valve is under the control of the operator. There is a reset knob on the counter so that counts can start from zero. The tool and the spare pens are packed in a strong plastic case for storage. *Hellermann Limited, Gatwick Road, Crawley, Sussex.*



## UPSETTER

### For Large Diameter Tubes

PRIMARILY designed for upsetting the ends of steel tubes, the horizontal forging press shown in the illustration can exert a force of over 2,000 tons.

Tubes up to 10 in diameter can be upset at the end so that screw threads can be cut, male at one end and female the other, to enable lengths of tube to be screwed together without the need of a coupling piece. The machine weighs in all about 200 tons. It was primarily designed for handling the tubes used in lining oil wells.

The main frame had to be made in two castings on account of size. The side slide which carries the gripping dies is operated through toggles by cams from the main crankshaft. This slide and the main slide are guided between anti-friction liners with automatic oil lubrication.

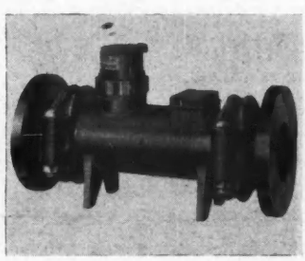
The forging operation is performed by a series of punches carried in the main slide which is driven directly from the crankshaft. Power is supplied by a 250 hp motor driving through V belts and reduction gearing. The stroke of the main slide is 30 in. As the operation is a single stroke one, a multiplate clutch and a disc brake are employed. They are designed to operate 15 times a minute.

Both clutch and brake are pneumatically operated and in the event of air or electricity failure, the clutch is disengaged and the brake applied.

The tubes are delivered to the machine from an end heater by manipulating rollers which raise them to the working height and move them into the dies in sequence. Power operation is used throughout. *Lamberton and Company Limited, Sunnyside Works, Coatbridge, Lanarkshire.*

## WATER METER

### Low Head Loss



FULL-FLOW and low head-loss are two features of a new range of water meters.

Four sizes of the meter, the type 33, cover a range of flows from 800 to 200,000 gallons per hour. They have two simple Victaulic joints for easy installation in a pipeline. Each meter is individually tested and calibrated and has a guarantee for a minimum error over the rated flow range of 2 per cent. The size of meter is determined by the flow to be handled and not by the pipe size.

The operation is based on a helical rotor mounted in plastic bearings on the meter body axis. Rotor speed is directly proportional to the flow velocity and the motion is transmitted to the index by reduction gears and a stuffing box. The gear mechanism and bearings are made from a low friction plastic material which eliminates friction and corrosion as well as reducing wear.

Straightening vanes at the meter inlet prevent turbulence and a regulator is included to give fine calibration adjustment. Only two bolts have to be removed from the Victaulic joints to allow the whole meter assembly to be removed for inspection and calibration; the pipe run need not be disturbed.

The type 33 meters can be used in conjunction with a very wide range of indicating and controlling devices. These include those typical of batching and blending plant such as multipointer or direct reading totalizing index, graphic recorder, flow rate indicator, strip chart recorder, summating counter and a series of dekatron tubes which can be preset to a batch. *Parkinson Cowan Measurement, Terminal House, 53 Grosvenor Gardens, London, SW1.*

## LIQUID EARTHING RESISTOR

### Negative Coefficient

LIQUID earthing resistors are now available in seven sizes for both indoor and outdoor use.

The model 7 illustrated is suitable for operation at 66 kV with a maximum current rating of 900 A or at 33 kV with a rating of 1,200 A. One of the main advantages of this type of resistor is that it has a negative temperature coefficient which allows the fault current to increase with increasing electrolyte temperature ensuring positive operation of protective relays. It is also more compact than its metallic counterpart and has higher thermal capacity.

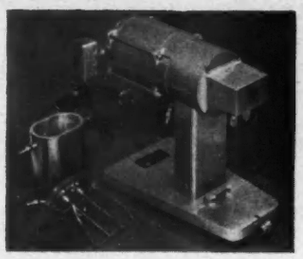
Each size will carry its rated current for 30 seconds with an electrolyte temperature of 50° C. They consist of a cylindrical steel tank containing the electrode and the electrolyte. The tank is continuously welded and galvanized. A level indicator is fitted and there is provision for mounting a current transformer.

The electrodes are either pear shaped or cylindrical according to the model, the size giving a low current density at fault rating.

To prevent the electrolyte freezing, heaters are usually fitted to outdoor models, 8 kW in the larger ones, and 4 kW in the smaller. They are thermostatically controlled. *General Electric Company Limited, Erith, Kent.*

## LABORATORY MIXER

### For High Viscosity Materials



HIGH VISCOSITY fluids and castable polymers can be mixed in a new 1 quart size machine.

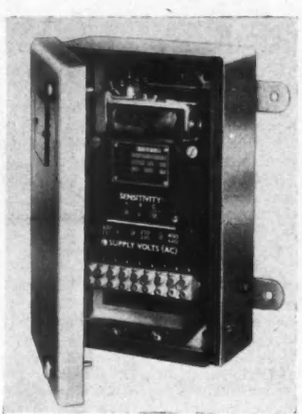
The model 60LP has two synchronised intermeshing blades and close chamber tolerances to ensure intimate mixing. The chamber is complete with vacuum connections and is jacketed for controlled temperature operation. A particular feature is that the mixer can be remotely operated using mechanical hands.

The bearings are located outside the mixing chamber so eliminating the possibility of contamination. All parts in contact with the mix are stainless steel and a Plexiglass lid allows observation. Although nominally of 1 quart (1,100 gm) capacity, batches as small as one-tenth quart (100 gm) can be adequately mixed. Blade speeds range from 50 to 250 rpm. The mixer is quickly disassembled for cleaning. Quick disconnect couplings linking the mixing blades to the gearbox give easy removal of the mixing chamber.

The motor is rated at ½ hp and is the movable brush repulsion induction type arranged to be explosion proof. The drive is through a water cooled gearbox with a 10 to 1 reduction. The mixing chamber has a total volume of 90 cu. in with a mixing capacity of 60 cu. in. An operating vacuum of 1 to 2 mm of mercury can be obtained. Maximum operating pressure of the temperature jacket is 40 lb per sq. in. The blades have a working clearance of 0·062 in. The complete unit measures 11 in by 20 in by 17 in high. The Plexiglass lid on the chamber cover rests on an O ring giving a vacuum-tight seal. A thermocouple is provided in the chamber. *Atlantic Research Corporation, Alexandria, Virginia, USA.*

## LIQUID LEVEL CONTROL

### Floatless System




A NEW RANGE of the Lectralevel floatless liquid level control system is now available.

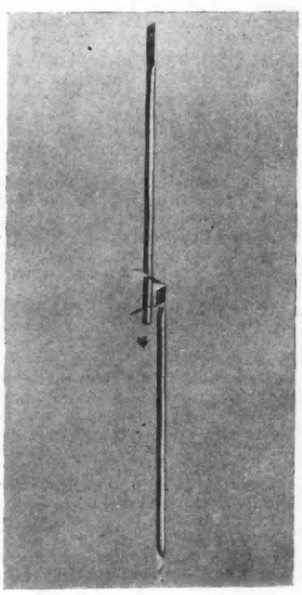
The system operates by the conduction of a small current of low voltage through the liquid. As alternating current is used there is no electrolysis and by using electro-magnetic relays no components likely to fail are used in the control unit.

The new unit, model LL/U1, is designed for most industrial applications. It can be arranged as a control for either filling or emptying, as a high or low level alarm or cut-out control. A sensitivity selector is incorporated making the one unit suitable for a variety of liquids with a wide range of conductivities. A voltage selector enables the instrument to operate from all standard mains supplies of 200-250 V or 400/440 V ac. The single pole output contacts are solid silver and are rated up to 2 A at 440 V. The case measures 9½ in by 7 in by 3 in deep.

A second control unit type LL/U2 is basically the same but is designed for more arduous conditions and includes fail-safe characteristics. The main contact is a single pole mercury switch rated at 20 A and the auxiliary contacts are rated at 2A at 440 V ac. Intrinsically safe and flame proof versions are also available. *Londex Limited, Anerley Works, 207 Anerley Road, London, SE20.*

## HANGER

### Infinite Adjustment for Height



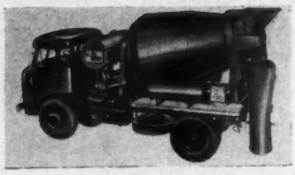
NOW to be marketed separately, the hanger shown in the illustration was originally developed for suspending illuminated ceilings.

It is extremely simple in construction and, since it will support a load of 400 lb, its uses can be extended for most fitments. The infinitely variable height adjustment allows the panels to be levelled up exactly.

The hanger itself consists of two aluminium tubes, each ¼ in diameter, and each with one end flattened and punched to form screw fixing holes. One tube also has a V shaped steel spring riveted on with holes in both arms of the spring, through which the second tube passes. The force exerted by the spring prevents the tube from slipping, but adjustments can be made simply, by releasing the spring by hand and sliding the tube through. The hanger is available for all suspension depths between 6 in and 6 ft. *Lumenated Ceilings Limited, Alliance House, Caxton Street, London, SW1.*

## TRUCKMIXER

### Hydrostatic Drive



THE VARISPEED is a high capacity truckmixer-agitator incorporating a hydrostatic drive.

The mixer is made in two sizes giving 4-4½ and 6-6½ cu. yd capacity. It is claimed for the drive that it produces smooth operation and precise control of drum speeds without gear changing or clutch operation. There is also a saving in weight and an improvement in efficiency. As a result bigger payloads can be carried and the agitator can be mounted on a short wheelbase truck.

Control of the drum for both charging and discharging is by a single lever at the control panel. The large hopper entry of 6·3 sq. ft makes for fast charging and quicker locating under the batching plant. Drum charging speed is 19 or 20 rpm, drawing the material quickly from the hopper. A shrink blade within the drum imparts a reverse mixing action as the drum rotates, clearing the way for following material.

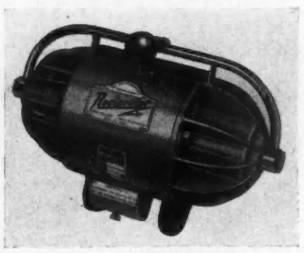
The large drum and the smooth drive allow a big blade area to be used resulting in better mixing. The low angle provides more air space above the mix and improves tumbling. A large pump and dual entry are designed for fast water penetration. A choice of three water tank systems is available. As far as possible parts have been standardized with other mixers available in the range.

The same design factors give a fast discharge and the chute gives a range up to 16 ft (when the extension pieces are fitted) over an arc of 150°. A tripod support is provided for the chute.

The hydrostatic system is driven from the power take-off of the vehicle and allows the drum to rotate at any speed up to 20 rpm maximum. The final drive to the drum is by a roller chain. Accessories include drum guards, fenders and splash guards. *Blaw Knox Limited, Short's Way, Rochester, Kent.*

## VACUUM-PRESSURE PUMP

### Electromagnetic



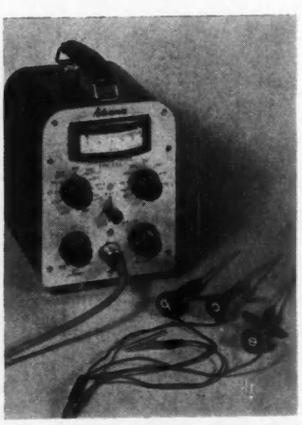
NOW available in this country is the Reciprotor combined pressure and vacuum pump.

The unit is operated by an electromagnetic vibrator supplied from an alternating current source. It is compact in design, weighing only 10 lb, and delivers completely oil-free air as no lubricant is required. The pump is available in two versions. The first, type 406G, is designed for continuous operation and gives free air displacement of 1·62 cu. ft per minute, a vacuum of 18 in mercury and a maximum pressure of 7·8 lb per sq. in. The second version, type 606G, is rated for intermittent operation only, but will deliver 1·77 cu. ft of free air per minute; it will attain a vacuum of 22 in Hg and a maximum pressure of 10·7 lb per sq. in. Standard models are for 220V 50 cycle supply.

The vibrator is mounted eccentrically and there is a common piston rod carrying a piston at each end. Piston rods and armature are mounted between springs designed to resonate with the mains supply. The length of stroke varies with the load. The pistons have self-lubricating nylon rings, the two outer ones being pressed against the walls by stainless steel springs. The cylinders are lined with polished steel sleeves rendering lubrication unnecessary. Under these conditions, ring life is from 2,000 to 4,000 hours. If the cylinders can be lubricated, the life is greatly increased. The suction and pressure valves give quick opening and closing even with small forces. Efficiencies up to 24 per cent have been measured and a feature of the pump is its quiet operation. *Edwards High Vacuum Limited, Manor Royal, Crawley, Sussex.*

## TRANSISTOR TESTER

### Checks Made in Circuit



LOW and medium power transistors can be checked while in circuit with the model TT1 tester now available.

Tests in situ avoid the risk of damage during removal particularly with printed circuit boards. Both pnp and npn transistors can be checked. Grounded emitter current gain may be measured in or out of circuit and leakage current with the transistor out of circuit.

The probes were specially developed for the purpose. The instrument is battery operated and includes provision for checking the batteries. Retractable legs are fitted to the front for bench working.

Current gain is measured in two ranges from 5 to 50 and from 50 to 500, with an accuracy of ± 5 per cent, with the transistor out of circuit. In circuit, the accuracy depends on the base shunt circuitry. The full range of set current is from 1 to 10mA but is reduced with transistors having betas below 12 or above 200. Shunt collector circuits of greater than 100 ohms can be balanced out. Leakage current is from 0 to 1mA or from 0 to 100μA.

The circuit is protected so that the battery drain is limited to 110mA. Overall dimensions are 6 in by 6½ in by 7 in and the weight 6½ lb. *Advance Components Limited, Roebuck Road, Hainault, Ilford, Essex.*

## TRACTOR SHOVEL

### Stand-Up Control

THE MICHIGAN 12B tractor shovel is designed primarily for industrial use.

The driver works from a standing position which enables him to mount and dismount quickly enough to effect a saving in time and fatigue. The shovel is powered by a Waukesha 42 hp diesel engine and has a Clark power train. This includes a torque convertor with a 3 to 1 ratio, power shift transmission and spiral bevel gear and pinion axle with planetary reduction in the wheels. Maximum forward speeds are 5·6 mph in first and 11·2 mph in second gear; top reverse speed is 10·5 mph.

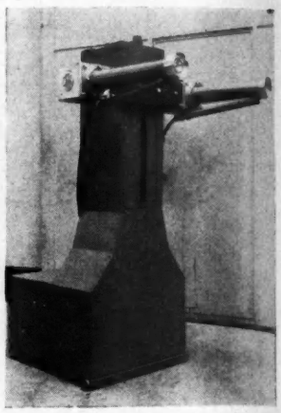
A wide range of buckets can be fitted from 13 cu. ft to 1 cu. yd capacity and from 42 in to 62 in wide. Lifting capacity is 3,520 lb. The shovel has a small turning radius giving it high manoeuvrability in close quarters. The total machine weight is 6,470 lb of which 2,970 lb is on the front axle and 3,500 lb on the rear.

The bucket action and control is hydraulic. The two boom cylinders have 3½ in diameter chromium plated piston rods and chevron ring packing. Both bucket cylinders are double acting and have the piston rods with the same dimensions as those of the booms.

The hydraulic pump has a capacity of 12 gallons per minute at governed engine speed and is driven from the engine timing gears. The valve is a two-spool type with a built-in adjustable relief valve. Accessory equipment includes a mounting plate for stoking ram, and forks. *Michigan (Great Britain) Limited, Export Division, PO Box 3, Yorktown Works, Camberley, Surrey.*

## ELECTROSTATIC PAINT SPRAY

### Automatic



NOW AVAILABLE in this country is the SAMES Megastatron electrostatic paint spray.

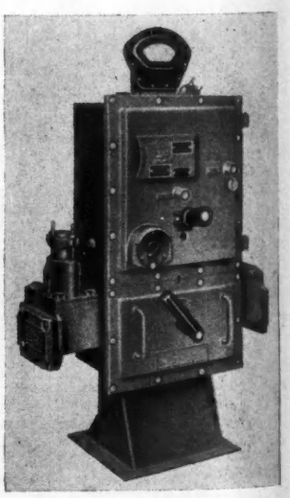
This machine uses the Felici generator of 150 kV rating and two atomisers, for which there is a set of six atomising heads. A wide range of ancillary equipment enables the unit to be tailored to particular installations.

Paint is delivered at low pressure (about 10 lb per sq. in) and is charged in the atomiser head which takes the form of a cylindrical cup. This cup rotates at high speed which with the charge on the paint particles gives good dispersion. The particles are attracted to any object at earth potential, so overspray is eliminated.

The unit measures approximately 3 ft by 2 ft by 1 ft. Input to the generator is either 220V or 380V 3 phase 50 cycles and a built-in control panel contains the stop and start buttons, indicator lamp, voltage adjustment and a voltmeter. The motors driving the atomisers are totally enclosed. The three heads have diameters of approximately 4 in, 6 in, and 8 in, giving paint outputs of 5½, 7½ and 11 gallons per hour respectively, which corresponds to areas of 2,700, 3,800 and 5,400 sq. ft per hour. Consumption is about 200 watts. *Aerostyle Limited, Sunbeam Road, London, NW10.*

## FLAMEPROOF STARTER

### Up to 150 Amperes



AN air-break direct-on-line contactor starter is now being made with a rating up to 150A on a 650V supply.

The starter has been certified as flameproof for Groups 1, 2 and 3 gases. The enclosure is a welded steel case divided horizontally into two compartments. The covers are also welded steel. The bus-bars are rectangular with a continuous rating of 200A. If required, bars rated at 400A can be provided. The insulator is housed in the lower compartments and mounted in unit with the bars on a frame. Interlocking is effected from the isolator.

Except for the earth leakage relay all interior components are mounted on a board which can be swung forward for inspection. The triple-pole contactor is rated for 150A and is operated by a small coil through a linkage. This reduces closing speed and contact bounce. The arc chutes are fitted with splitter plates which are efficient enough to dispense with blow-out coils. Overload protection can be provided either by solenoid operated relays with oil dashpots or thermal relays. Earth leakage can be fitted if required. *Belmos Company Limited, Bellshill, Lanarkshire.*

# Catching Burst Slugs

Burst slug or burst cartridge detection equipment for a large gas cooled type of reactor used in the present generation of nuclear power stations is probably one of the most extensive and complex instrumentation systems for measuring a single plant parameter in use today. Its technology involves a wide cross-section of specialists. It is imperative to be able to detect a release of radioactivity from a burst fuel element as soon as it occurs, and it is necessary for the equipment to be able to cater for both rapid and slow leaks giving a range of detection over several decades. Although the expense and complexity of the system are large, it is a sound investment if accidents to the degree of Windscale can be averted.

### Types of Failure

With sufficiently sensitive instrumentation, bursts may be classified into four categories according to their evolution speed as follows:

1. Evolutions from several days to several weeks—these bursts are rare.
2. Evolutions during 24 hours—which appear to be the most frequent.
3. Evolutions within about one hour, requiring carefully thought out techniques to detect the bursts without disturbing the operation of the reactor.

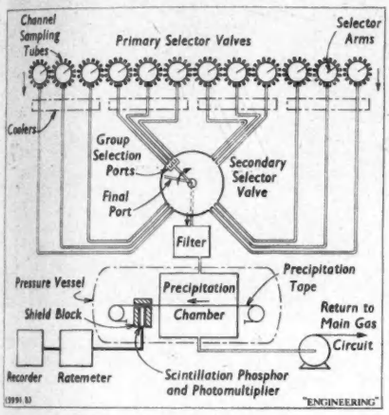



*Fig. 1 Schematic selection of the coarse and fine selectors.*

4. Instantaneous evolutions: these are the most serious but, fortunately, the rarest.

Experience has shown that the law of evolution in time usually corresponds to an exponential scale, so that rapid detection is essential. The period when bursts are most frequent appears in the first power rise with a new core loading or at the following loading operations. If the reactor can be loaded during operation, the fuel element is immediately subject to high thermal strains which rapidly release a latent failure. Elements that have undergone high irradiation rates are particularly prone to failure.

### Possible Methods of Detection

In a paper read at the Society of Instrument Technology last month by F. T. Law entitled "The Principles of Burst Cartridge Detection Systems" the following methods were given for the detection of failed elements:

1. The enclosure within the can of a tracer fluid that would be ejected into the coolant circuit if the can failed. However if the fluid is not detected immediately on release it would circulate through all the channels in the reactor, and it would then be impossible to locate the offending channel.

2. A system could be devised for detecting the small portion of fission products which are delayed neutron emitters. A disadvantage of the system is that the sensitivity is reduced by the presence of oxygen 17 in the carbon dioxide coolant. Under irradiation the oxygen 17 gives nitrogen 17 which subsequently decays to oxygen 16 with the emission of a neutron. The system could be satisfactory if a method is devised for isolating the delayed neutron emitters issuing from the unranium from those present in the coolant.

3. A direct measurement of activity of the coolant gas could be made. The sensitivity of this method, however, is masked by the parasitic activity of the coolant itself, which will contain oxygen 19, argon 41, carbon 14 and nitrogen 16. It may be possible to reduce the effect of these parasitic activities by discriminating in favour of an energy and containing only active particles escaping from the fuel elements.

4. A method similar to 3 above, whereby the activity of the coolant is measured in an indirect fashion. The coolant sample is drawn through a filter into a precipitation chamber which has a central electrode, maintained at a negative potential of several thousand volts. Thus gaseous fission-products which have passed through the filter then decay to ionized particles which adhere to the wire. After the wire has been allowed to accumulate a reasonably large number of these particles it is withdrawn to an adjacent chamber where a counter measures the decay of the particles deposited on the wire.

The last method is the one which has so far yielded the most profitable results. The main advantages of method 4 are that most of the particles which contribute to coolant activity have only one stage of decay, and therefore when they are deposited on the wire they become inactive and do not contribute to the activity as measured by the counter.

### System Components

The detection system for gas cooled reactors, shown diagrammatically in Fig. 1, may be divided into three main components:

1. Sample selection and scanning system;
2. Precipitator unit;
3. Display or data processing equipment.

### Scanning and Sampling Equipment

Each fuel channel is connected through a small bore tube to a system of selector valves. Since the number of channels in a current reactor is in the order of several thousand it is impossible to devote to each reactor channel one set of

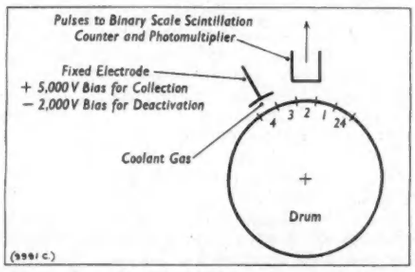

Pulses to Binary Scale Scintillation Counter and Photomultiplier
Fixed Electrode
+ 5,000 V Bias for Collection
− 2,000 V Bias for Deactivation
4 3 2 1 24
Coolant Gas
Drum

*Fig. 2 Principle of the French precipitator unit.*

equipment for continuous measurement because of the expense and volume of equipment required. Multi-way valves operate so that a sample of gas is taken from each channel at regular intervals. The distance of the valve from the fuel channel is important in view of the expense of the stainless steel piping for each channel. Since Calder Hall the valves have been positioned nearer and nearer to the reactor. At Bradwell the outlet of the BSD pipes was combined with the reactor control rod function, with an 18-way selector valve mounted on the control rod stand pipe. At Hinkley Point a large multi-port selector valve was fitted directly to the stand pipe of the reactor pressure vessel, and at Dungeness a 32 way valve is placed in the control standpipe shield plug. The valves may have to operate in the dry atmosphere of carbon dioxide without lubrication at high temperatures and maintenance.

### Coarse and Fine Monitoring

In order to have a rapid scanning system two forms of scanning are used. The coarse scan monitors a group of channels, the current number being eight but this may increase as technology improves. The number that is grouped has a direct bearing on the detection sensitivity. The coarse scan is used to detect the more rapid bursts. The fine scan, which takes individual channels is used to detect the slower bursts.

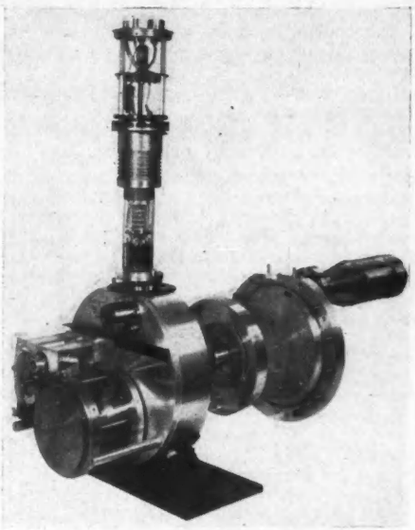


*Fig. 3 Drum type of precipitator made by Intertechnique and developed by the French Atomic Energy Commission.*

### Precipitator Unit

After being filtered to remove all solids the gas passes to the precipitator unit which is placed in an area of low background activity. The unit consists of a pressure vessel containing an electrostatic precipitation chamber, a scintillation counter, and a tape or drum transport mechanism. The use of a drum is a recent development by the French. Tape transport is employed by Plessey Nucleonics Limited and the General Electric Company.

In the Plessey Nucleonics system the gas is precipitated on to a wire for 30 seconds and then the wire passes under a detector in another chamber for 30 seconds. About 120 operations pass before the same section of wire is used, resulting in a residual activity in the wire of 5 to 15 per cent. In the French system, shown in Fig. 2, the sector assigned to the channel is on position No. 1. During the one minute cycle the same gas sample is flowing through the precipitator. The drum moves to position 2 under the scintillation counter for about 10 seconds and a measurement is taken. It then moves to position 3 for 25 seconds for the collection period, when a + 3,000 V bias is applied to the fixed electrode. The drum returns to position 2 for 10 seconds and the total measurment is taken. At the beginning of the next cycle the sector moves to position 3 again and a − 2,000 V bias is applied to the fixed electrode to deactivate the sector. Since there are 24 sectors this section will not be used for the next 23 minutes. The fission gas activity is given by the difference in the two readings. An exploded view of the precipitator unit is shown in Fig 3, and a block diagram of the system in Fig. 4.

### Components of the detected signal

If a scintillation counter alone were to replace the precipitator unit it would respond to activity

from a number of sources:

(1) Fuel contamination.

The fuel surfaces are covered with minute amounts of natural uranium which have been desposited during the manufacturing process and have not been removed during the subsequent cleaning operation. The uranium 235 will undergo fission during the reactor operation and this will produce fission products in the coolant which have the same characteristics as fission products from a burst fuel element. There will also be contamination from fission products released during previous bursts. This "background" will always exist and during the life of the fuel it may be expected to grow as the contribution from very small bursts ensues.

(2) Active isotopes in the reactor coolant gas.

The coolant contains oxygen 19, argon 41, carbon 14 and nitrogen 16 which are gamma emitters.

(3) External gamma radiation from the reactor and cosmic sources.

Although it is of a very low order of magnitude there is an attenuated gamma flux from the reactor and cosmic radiation in the BSD room. This can be eliminated by the thickness of the precipitator pressure vessel.

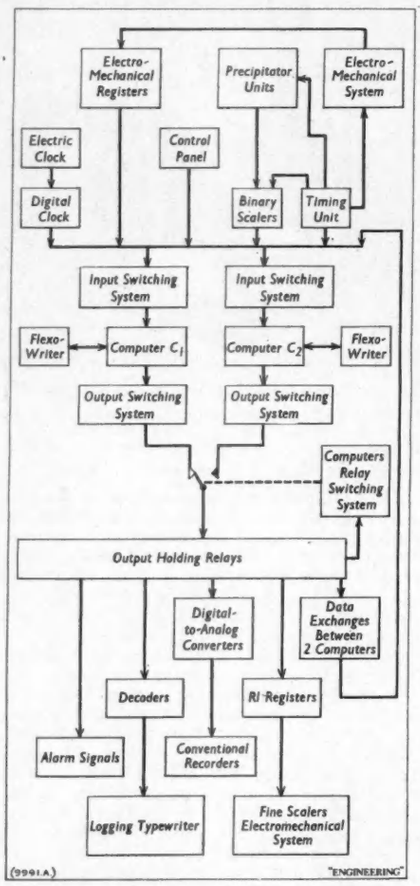



*Fig. 4 Block diagram for the French system including two RW-300 computers.*

(4) Additional fission product activity when a burst occurs.

(5) Counter noise arising from temperature and avalanche effects associated with the photomultiplier.

**Comparison of the Two Designs**

Neither of the two systems has a complete answer to all the problems. The French Atomic Energy Commission originally used the English type of precipitator on their reactors, but now the EDF1 and G3 reactors are fitted with the drum precipitator made under licence by Intertechnique. Miles Hivolt Limited are the agents in this country. The drum has been adopted in order to overcome the difficulties experienced by wires breaking in the English system and to give a wide area of precipitation. However the use of spiral wire has greatly reduced breakages and the repair time is short.

The coolant gas is allowed to pass through the drum precipitator during the complete cycle—in time this will give a high background or residual activity in the measuring chamber, which could become excessive if a bad failure occurred, giving a background reading higher than that for the newly released fission products. In the English system this is partially overcome by having the precipitation and measuring chamber separated. The French claim that the judicious use of two RW-300 digital computers overcomes this. With the provision of reference values and the use of an evolumeter to eliminate the unwanted contributions to the reading it is possible to store each reading so that it may be compared with the previous reading for the same channel although this individual reading comparison is prone to larger statistical variation. However, because the value of activity will vary in each channel as the age of the reactor increases, this is a strong point in favour of successive comparison.

Since the construction of Bradwell the English reactors have been fitting more and more complicated displaying and data processing equipment, and Sunvic Controls Limited have developed a digital computer for this purpose. The equipment also makes it possible to make correction in the average weighed count for temperature and changes in flux levels. Without this the threshold value is chosen to take into account the highest background contribution that can be expected, before an alarm is tripped. This is a disadvantage in discovering slow bursts. In the French system—a healthy section will show a zero useful signal.

**Latest Developments**

The Advanced Gas Cooled reactor at Windscale has 253 channels and a matrix system is used to detect a failure 16 channels are parallelled in both the $x$ and $y$ direction, requiring a total of 32 monitors. This system has the advantages that:

1. A faulty channel is immediately identified by the signal from two coordinates.
2. All channels are monitored all the time giving an immediate response to failure.
3. Irregular or puff releases are detected and this information is stored.
4. The detector may be optimized by altering the sampling time to examine slow bursts, if necessary.

It is now possible to make multiple precipitator units containing eight precipitator chambers in a single pressure vessel, as shown by the Plessey Nucleonics Mark 6 model in Fig. 5. For a reactor of 256 channels, four such units are necessary with the matrix arrangement.

The matrix system can be used for an arrangement greater than 16 × 16 but there are several disadvantages:

1. There is a limit to the number of channels which may be paralleled set by the fineness required in the sensitivity.
2. Ambiguity is possible if more than one burst occurs in the matrix.
3. Obstruction of a sampling channel may not be noticed and is difficult to clear unless all pipes are brought out from the vessel.
4. Pipes from a burst channel may become seriously contaminated giving a high background to the groups in the matrix.

**GEC Progress**

The General Electric Company has supplied each of their reactors with their own designed and constructed BSD system. In 1960 the Mark III precipitator was introduced and is capable of withstanding pressures up to 400 lb per sq. in. In the present English system the effect of pressure is small at the levels encountered in the current reactors, but spurious effects may dominate as the pressure increases. The effect of temperature is described in a report published by the United Kingdom Atomic Energy Authority—IGR-TN/W264. The Mark III is being used in experimental loops in the R3 reactor in Sweden and DIDO. It will also be installed in the Tokai Mura reactor in Japan.

A laboratory has been commissioned at Erith for further experimental work on BSD equipment. Gas pressures up to 500 lb per sq. in can be supplied and water cooled systems are being investigated.

**Water Cooled Reactors**

The detection of burst fuel elements in water-cooled reactors may be achieved by a system similar to that used in gas-cooled reactors but with the addition of a simple scrubber unit which removes fission-product gases from the water coolant. An inert gas such as helium is passed over an extended water surface and the majority of dissolved gases are transferred to the helium which acts as a carrier. This carrier gas is then passed through a precipitation unit. The sensitivity of this type of detection system is usually greater than that obtained in gas-cooled reactors since, for a given size of burst, the concentration of fission products in the carrier gas is greater. In many systems the scrubber unit may be incorporated in the fuel element design but, if preferred, external scrubbers can be supplied. As the number of channels in water-cooled reactors is usually considerably smaller than in gas-cooled reactors, selection of water samples can conveniently be made by means of solenoid-operated valves. Special stainless steel valves of this type are available mounted on a mainfold with common exhaust ports.

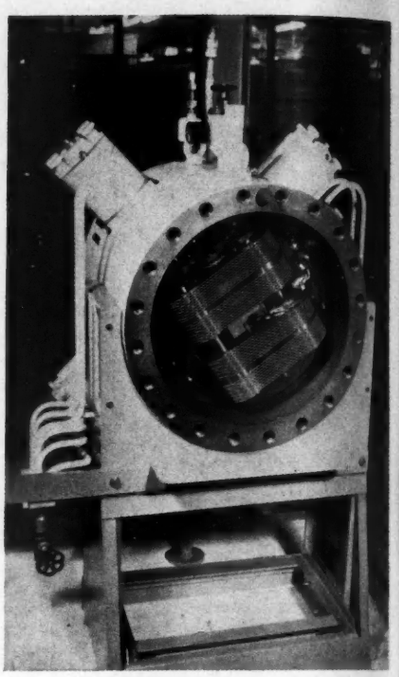


*Fig. 5 Mark 6 precipitator made by Plessey Nucleonics for the AGR at Windscale. There are eight precipitator chambers in one vessel.*

**Future Reactor Systems**

As higher burn-ups are achieved and higher temperatures employed, for example in the Dragon Project, the level of fission products in the coolant will be much higher than in the present gas cooled reactor systems since there is no guarantee that the cladding will stop all fission products. In this case the background activity will be very much higher and the French system, with coolant flowing through the chamber during the complete cycle, will have a harder problem to overcome than the English system with the chambers for precipitation and measurement.

# Companies

## ICI Export Sales Pattern Changing

PRICE reductions made by IMPERIAL CHEMICAL INDUSTRIES last year reduced the 11 per cent increase in the volume of home sales to a 9 per cent growth in value over 1959. The 2 per cent decline in overall home prices was equivalent to a reduction of about £5 million in income.

External sales of the group last year rose by £50 million to £558 million. Manufacturing and trading profits, after depreciation, were £93·6 million, against £79·8 million for the group and £74·5 million, compared with £63 million for the company. This is a 17 per cent increase for the group and 18 per cent for the company.

A lower rate of profit was earned in the latter half of the year, due to the reduced selling prices and higher wages and salaries. As a percentage of the total funds invested, the group income before tax, debenture and fixed loan interest was almost the same as back in 1951. The 1960 figure was 13·2 per cent, in 1951 it had been 13·4 per cent. The ICI group total assets, less current liabilities, have increased over the same period from £307·4 million to last year's £695 million.

While the assets have been rather more than doubling, the income expressed as a percentage has varied a few points, dropping to 9 per cent in 1952 and 8 per cent in 1958 (after the revaluation) but never rising higher than 1951's figure of 13·4 per cent.

Almost all of ICI's divisions shared in the increasing sales. Bouyant conditions in textiles helped Terylene polyester fibre to make a major advance. All the plants of the Heavy Organic Chemicals division were operated at high output rates and there were notable sales increases in the intermediates for plastics, paints and resins manufacture.

**ICI Home Sales**

| Consuming industry | Value of sales, £ million | Percentage of total sales, Per cent |
|---|---|---|
| Agriculture | 53·7 | 18 |
| Textiles | 47·0 | 15 |
| Engineering (less motor and aircraft) | 32·0 | 10 |
| Chemicals | 26·4 | 9 |
| Motor and aircraft | 18·3 | 6 |
| Building trades | 15·3 | 5 |
| Plastics | 14·3 | 5 |
| Mineral oil refining | 8·8 | 3 |
| Mines and quarries | 8·4 | 3 |
| Government Departments and Public Authorities | 6·1 | 2 |
| Glass and ceramics | 5·4 | 2 |
| Paper and paperboard | 4·8 | 2 |
| All other trades (including chemical merchants and other wholesalers) | 62·6 | 20 |

Although the wet 1960 autumn handicapped farmers, record quantities of fertilizers were used and ICI fertilizer sales went up accordingly.

ICI exports for the year were a record. Their value increased 10 per cent to £96·6 million. This was despite the falling sales of fertilizers and some important base chemicals in which the trend is towards local manufacture. Through overseas subsidiaries and associates ICI has in recent years been turning to the production of base chemicals in its former export territories. A leading example of this move is the manufacture of dyes, explosives and polythene in India.

Sales outside the United Kingdom of chemicals produced by ICI overseas subsidiary companies are now about equal to exports of UK produced chemicals.

Expansion in UK chemical exports depends more and more upon the more sophisticated and newer products. The value and volume of these more recent products has increased four-fold in the past decade, making possible the 100 per cent increase in ICI exports during that period.

The changing pattern of the group's markets, with industrialized states taking over from less developed territories (apart from the overall increase to Africa) is clearly shown in the following table.

**ICI Exports Analysis**

| | 1959 Value of exports (fob) | 1960 Value of exports (fob) |
|---|---|---|
| | £ million | £ million |
| Commonwealth of which | 36·8 | 36·2 |
| India, Pakistan and Ceylon | 11·6 | 10·5 |
| Africa | 8·9 | 9·7 |
| Australasia | 7·4 | 8·3 |
| Canada | 2·0 | 1·9 |
| European Economic Community (The Six) | 11·0 | 13·9 |
| European Free Trade Association (The Seven) | 11·3 | 14·0 |
| USSR and Eastern European States | 3·4 | 5·5 |
| Rest of Europe | 6·1 | 6·8 |
| United States of America | 3·9 | 4·0 |
| Central and South America | 6·5 | 6·7 |
| Remainder | 8·5 | 9·5 |
| Total | 87·5 | 96·6 |

The construction programme in the United Kingdom took £34 million, compared with £32 million the year earlier and £45 million in 1958. Since the emphasis is now changing from expanding capacity by relatively low cost modifications to existing plants towards investment in the building of new and larger plants, the company's capital expenditure will return to the substantially higher levels of the years before 1958.

## Export Success Sustains Condensers

One of those companies particularly dependent on the state of the consumer market and therefore on Government monetary policy is the TELEGRAPH CONDENSER Company. Their annual report shows how vigorous overseas efforts, lifting the company's export sales to record levels and development of the industrial condenser side, have substantially held off the worst effects of the severe reduction in demand from the home entertainment industry in the later months of last year.

The group trading profit for the year declined from £770,679 to £701,737, a drop of £68,942. That the trading profit was not materially lower was due to the improved results from the industrial and overseas divisions. Further capacity on the industrial side is expected to become available during this year in a considerable extension of the Scottish factory.

Overseas, where the demand for the company's condensers continues high, TCC have concluded a number of agreements with the SPRAGUE ELECTRIC Company, of North Massachusetts, USA, covering the exchange of techniques and patents and giving TCC exclusive agency rights for the distribution of Sprague products in Great Britain.

With the immediate outlook in home entertainment appliances not very encouraging TCC are expecting that demand from manufacturers in some industries may be below the overall 1960 level.

## BOAC Seat System Going Electronic

The BRITISH OVERSEAS AIRWAYS CORPORATION are to have an electronic system giving ticket offices in the United Kingdom and Europe minute-by-minute information on seat availability on all BOAC flights. The system will be supplied and installed by STANDARD TELEPHONES AND CABLES Limited.

The information will be available for flights up to 20 weeks in advance. Services of other lines associated with the Corporation will be covered in the scheme (shown in diagram below).

A central magnetic drum store of flight information will initially serve about 100 sales personnel using special sets at the BOAC terminal building in Buckingham Palace Road, near Victoria Station, London. Using telegraph circuits, the system will later be extended to a number of points in London, including London Airport. Extensions are planned to such major United Kingdom centres as Birmingham, Belfast, Manchester, Leeds and Glasgow and to a number of European cities. Additional facilities include the reporting of sales and cancellations over long distances automatically and at high speed.

When the development of the machine has reached this last stage the inventory of seats sold on each flight will be carried out in the system. Changes will be required in the central equipment, but not on the keying equipment supplied at the start.

Information on the availability of seats will be obtainable on the new system in a few seconds. In its early stages booking will be by telephone or teleprinter. In later phases up-dating of information and seat inventory will be automatic. Seats will be booked with the push of a button.

The system's four principal parts are: the sales clerk's desk set, a large number of these will be in use at the terminal building and at British and European sales offices; the controller's desk set, there will be several of these sets at the central control point at BOAC's Airways Terminal; the supervisor's console, at Airways Terminal; the Information Store, at Airways Terminal.

Designing the system, from which an extremely high standard of reliability is essential, Standard Telephones and Cables have relied on well-tried components and assembly techniques with transmission speeds and error-checking correction facilities on communication networks which are available at economic cost from the postal authorities over whose territories the communications are linked.

The central information processor has a capacity of 8,000 interrogations an hour. At the keyset, the operator of a selling position will receive a warning from the system if:

He has sent to the centre an incomplete message on an availability inquiry.

His message has been damaged by a transient failure of the communications lines used by his keyset.

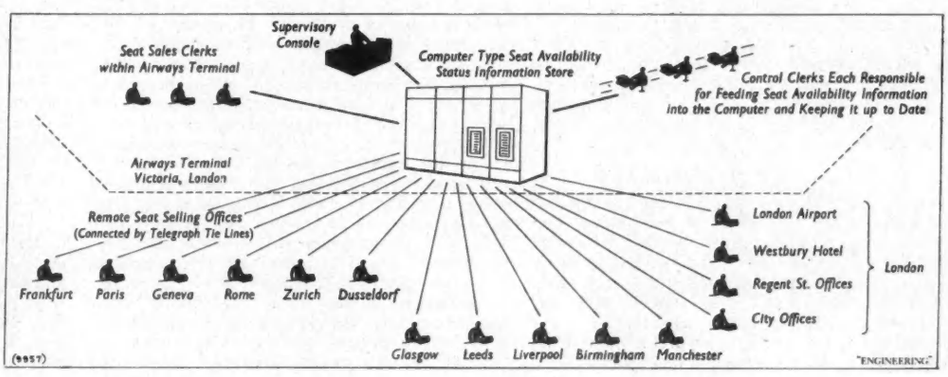
There is a complete failure of the line associated with his keyset.

The central information store is out of action.

At the supervisor's console at Airways Terminal a special system of alarms and consistency interlocks is provided to make certain that the supervisor cannot initiate a damaging routine by setting up the wrong buttons accidentally.

## AEI and GEC Form another Joint Company

Following their formation last December of a joint concern for the production and sale of glass products, ASSOCIATED ELECTRICAL INDUSTRIES and the GENERAL ELECTRIC Company have reached an agreement to set up an additional joint firm. The new organization, being formed this month, will manufacture and sell molybednum, tungsten and other metal products associated with the electric lamp and radio valve industries.



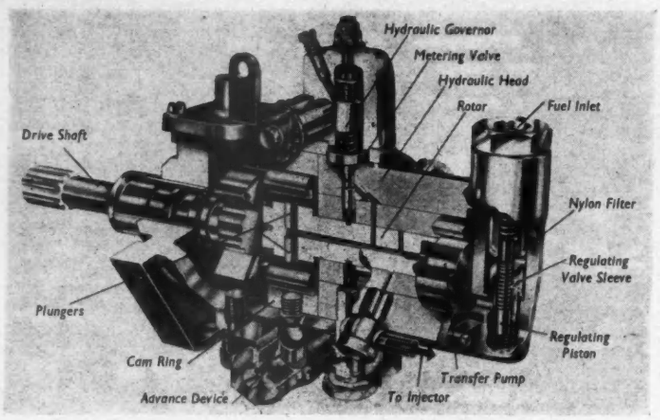



*Fig. 1 The hydraulic governor version of the DPA pump. The mechanical governer type has a bigger pump housing.*

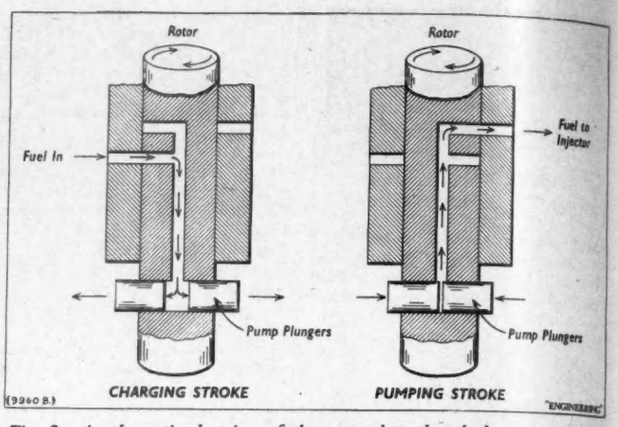



*Fig. 2 A schematic drawing of the pump barrel and plunger mechanism in the DPA distributor pump. There is a separate outlet port supplying each cylinder precisely as required.*

# Simpler Designs Complicate Production

**Simplicity on the drawing board sometimes presages problems on the shop floor. These problems can be the more acute if, to be economic, production must be large scale.**

WHEN, in 1956, CAV Limited's design engineers produced the prototype DPA distributor fuel injection pump, they had designed a pump (Fig. 1) which was smaller, lighter and easier to install than the older " in-line " pump and which was provided with accurate fuel distribution through high precision machining of its rotor and head. Unfortunately, though, these design engineers, by the very simplicity of their ideas, had also presented their production colleagues with the problem of establishing a mass production line able to manufacture and assemble to tolerances so close—even below 1 micron—that new measuring techniques were necessary to check them.

The DPA distributor pump, using one pump barrel and plunger to supply all cylinders in turn with the mechanism illustrated in Fig. 2, is a much simpler and more economical pump than the in-line pump which requires a separate pumping element for each cylinder. The difference in design between the two types is so radical that the 320 components in the in-line pump have been reduced to a mere 145 components in the distributor type, a factor which might appear to simplify production.

In practice, however, production has been made more difficult by the emphasis thrown on precision work. The metering of fuel through a distributor pump demands careful construction. The timing of the injections must also be perfect to attain high efficiency, and since the operating pressure might be as high as 6,000 lb per sq. in, the pump must be made to very close tolerances.

That CAV's production engineers have succeeded in meeting the exacting requirements set by their designers was demonstrated last week by the celebration to mark the production of half a million DPA pumps at their Rochester factory. Indeed, the second quarter million has been produced in the last 18 months and current production is at a weekly rate of 20,000 pumps.

## MANUFACTURING PROBLEMS

Of the changes in production necessitated by the introduction of the new type of pump, the most fundamental were probably concerned with the designed accuracy of the rotor and head which form the pumping and distributing unit. Previously, such accuracies could only be obtained by making large quantities of component parts, and then grading and lapping them together. To attain economic mass production, it was important to eliminate this type of lapping operation but this meant machining a hole round and parallel to a geometrical accuracy of rather less than one micron or 0·00004 in.

Indeed, the geometrical dimensions in the porting areas of the head and rotor assembly must be to an accuracy of half a micron, and the controlled clearances of the rotor in the head are from two to three microns with a surface finish of 3 micro-inches maximum.

It was decided that the head and rotor should be honed, but no ready made machine could be guaranteed to work to these close tolerances. CAV themselves therefore carried out research work on standard machines until, after many months, they were able to finalise both the design of tooling and the automatic control of sizing.

To machine the porting holes in the rotor and sleeve, special machines were made with drilling units mounted in fixed positions for four and six cylinder designs. Thus, there could be no possibility of human error during changeover setting but, even so, it was very important that fixtures, drill bushes and cutting tools were made and maintained to the finest limits.

As mentioned in the caption to Fig. 1, there are two types of housing, one for the hydraulic and the other for the mechanical governor. Production of both types is carried out in three stages, (*a*) the initial chucking operation on vertical automatics, (*b*) a multiple milling, drilling, spot facing and tapping series of operations, and (*c*) a final finish machining of the bores.

From the first stage, the housings are passed to an electromechanical transfer machine where they are loaded, transferred through the various machining stages, washed and returned to the starting position for unloading.

Another vital component in the DPA pump is the cam ring. The pump depends greatly on the accuracy and perfection of the internal cam ring, the number of rings of which correspond to the number of cylinders. Production of this component is by flow line methods, some of the operations before hardening being fully automatic. A special internal grinding machine has been developed with a work head capable of carrying several master cam forms in one block to reduce changeover time. Wheel dressing and sizing are carried out automatically.

Production of the cam roller shoes also had its peculiar problems, the chief one being the grinding of the bore. Had this been a half circle or a little less, it would have been comparatively simple to place two components together and grind them at the same time. However, since the bore of the shoe is rather more than a half circle, the operation is more complicated and the intermittent cut made by a standard type of internal grinder produced an unsatisfactory result. The solution has been to use a specially designed reciprocating table grinding machine with two grinding spindles and a four-spindle work head, plus hopper feed.

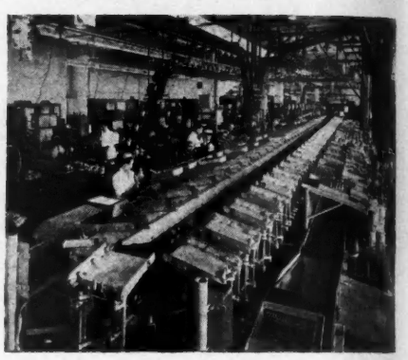


*Fig. 3 The main assembly line, showing some of the conveyors and component tote pans.*

## ASSEMBLY

The machining sections feed by conveyor to the main assembly shop line shown in Fig. 3. Sub-assemblies, such as the hydraulic head and rotor unit, arrive at the assembly line by conveyor, the other components being delivered to the assembly operators in tote pans.

Batches of components are arranged for convenient handling—the work study engineers have been active here—and fixtures, pneumatic clamping devices and tools are provided at the assembly stations. As is the rule throughout production, all cleaning of components is by washing, not by wiping, in order to guard against the possibility of foreign matter getting into the pumps. At the end of the assembly line, six gallons of filtered oil are flushed through each assembled pump in 18 seconds to ensure the removal of any lingering dirt particles.

The final operation is to check the freeness of the drive hub and the operating levers, and record the serial numbers on an electric typewriter. Then the pumps are passed by conveyor to the Hartridge test machines which simulate operating conditions.

When it has passed this final rigorous test, a DPA pump is ready for dispatch to any of the markets, here or overseas, which have opened up to this product in agricultural, road transport and marine diesel driven engines. CAV Limited, who have their head office at Acton, London, W3, have established an impressive technical lead in spite of foreign competition, exporting 65 per cent of their fuel injection pumps.

## More Coal Won by Machine

It appears that the National Coal Board mean business in their current drive to increase productivity and reduce production costs. The output per shift worked at the coal face is already at record levels and the Board now intend to improve operating efficiency still further.

Mechanisation at the coal face has made the major contribution to recent advances in productivity, but it has been accompanied by ancillary measures including improvements in roof supports, more conveying and locomotive haulage, redeployment of manpower and, where necessary, the closure of uneconomic pits. The latter two points are part of the policy of concentrating production effectively.

The superseding of the pick and shovel by power-loading of coal had made little progress in this country until machines suitable for British mining conditions (very different, for example, from USA conditions) began to be developed about ten years ago. In 1950 only 3·8 per cent of the total tonnage was won entirely by machine, but in 1960 the figure was 38·2 per cent. This year, 400 new machines are being installed with the object of raising the annual production of mechanically mined coal to 105 million tons compared with the 83 million tons of 1960.

There are three machines principally concerned in mechanised coal getting—the Anderton shearer loader, the trepanner and the coal plough. The Anderton shearer is efficient, reliable and—an important characteristic—versatile but, because of the current demand for large coal, the emphasis at present is on installing more ploughs and trepanners.

An interesting aspect of the current step forward by the NCB is the number of examples of improvements made at the suggestion of the Board's employees. These include, as isolated examples, a gum stower plate devised by a coal cutter at Peasley Colliery and a dry coal cleaning plant designed by a technical assistant with the East Midlands Division. When this sort of thing happens in industry it usually indicates that there is a healthily progressive atmosphere in the firm concerned.

## New Hydraulic Bench Press

Tangyes Limited, of Smethwick, Birmingham, have now produced a small bench press incorporating their " Hydrapak " two-speed hydraulic hand press. On show at the Engineering, Marine, Welding and Nuclear Energy Exhibition, it is of 10 tons capacity and is probably the first of a range of other capacities.

It is a downworking press with a 2½ in diameter ram and a stroke of 5 in, the hydraulic piston being 3¼ in long. The work table is 11 in from the bottom of the fully withdrawn ram, and covers an area 13 in wide by 10 in deep. With the Hydrapak pump set on the low pressure position, three strokes of the operating lever will move the ram one inch. This low-pressure setting is suitable for pressures up to about 2½ tons and for advancing the ram quickly to the workpiece.

For higher pressures up to the maximum 10 tons, the pump is set on the high pressure position and about 17 strokes of the handle are then required for each 1 in movement of the ram.

The press frame is fabricated from steel plate and pressures are read from a 4 in diameter gauge positioned at the front of the frame.

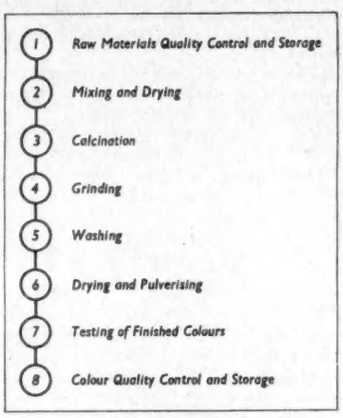
*The press in operation.*

## Producing Colour Oxides for Ceramics

With the completion of Ferro Enamels Limited's new factory at Wombourn, Wolverhampton, one of Europe's most up-to-date colour oxide plants will shortly be in production. When it is fully operational, it will produce 350 tons of colour ceramics annually.

Each batch of incoming raw materials is subjected to a strict chemical analysis to ensure that it meets the rigid specifications laid down for the individual materials. These specifications also lay down exacting requirements in the physical state of the materials.

The first production operation, as illustrated by the Operation Process Chart, is mixing and drying. Mixing is a crucial stage in production because materials for colour manufacture must be of very fine particle size and must be well mixed to ensure complete chemical reaction during calcining.


1 Raw Materials Quality Control and Storage
2 Mixing and Drying
3 Calcination
4 Grinding
5 Washing
6 Drying and Pulverising
7 Testing of Finished Colours
8 Colour Quality Control and Storage

*The Operation Process Chart.*

There are three alternative methods of mixing, the material passing through whichever is appropriate to its properties. The methods are known as (*a*) wet milling, (*b*) dry mixing, and (*c*) slurry mixing. The first entails grinding in a normal ball mill with water as the medium, while dry mixing is a basically similar process but without the addition of water. Slush or slurry mixing is used for one particular type of colour, complete mixing being accomplished relatively quickly in a stainless steel or plastic lined open ended drum.

After drying, the raw material passes to the calcination process, by way of the micropulveriser. It is loaded into saggers which are made of refractory material/fireclay compositions to withstand the high temperature of calcining without reacting with the material being calcined.

Calcination of the raw materials is necessary for the promotion of the final colour by solid-state reactions. Depending upon the material content and the end use of the colour, the firing cycle may be anything from 10 to 40 hours, with a maximum temperature from 800° C to 1,350° C and soaking periods up to 12 hours. Control of these high temperatures is by Honeywell-Brown instrumentation.

Grinding is necessary after calcination since most colours have to be reduced in particle size. In some cases the calcined material is friable and easily broken down but in others it is completely fused. The normal ball mill is used with either porcelain or high-density balls as grinding media.

With some oxides a hot water washing process is then needed to remove soluble salts which, in the later stages of enamelling or glazing, would cause undesirable defects.

The colour is then dried either by being pumped to a tray type dryer or by the use of a string discharge vacuum filter which consists of a drum under vacuum being rotated through a trough of liquid or slurry oxide. By a valve system the vacuum is released at a certain point of rotation and the cake is discharged to trays by strings wound round the drum and by a roller outside the trough. Drying is completed in a series of gas heated box dryers.

After drying, the finely ground material is often caked and agglomerated and has to be disintegrated to a consistency similar to face powder by a micropulverisor. Samples of each finished colour are then Laboratory tested.

The finished colour oxide is then packed in polythene-lined fibre containers to ensure that it cannot absorb moisture in transit and can be handled easily in the customer's plant.

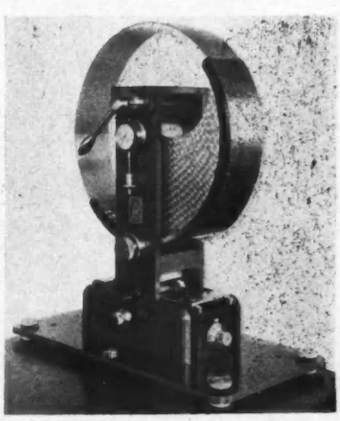
## Prototype Carton Board Creaser

Too often, a product which has been manufactured to a high standard of quality and appearance is packed in a substandard carton that can spoil much of the good work on the product itself. Research at PATRA—the Printing, Packaging and Allied Trades Research Association, of Leatherhead, Surrey—has shown that the failure of such cartons is often the result of internal resistance to folding of creases of outwardly good appearance.

PATRA have now produced a prototype carton board creaser, as illustrated, which can study the basic factors in board creasing under different operating conditions. This prototype creaser will be followed by a commercial model within a few weeks.

The instrument measures the creasability of a board to discover the range over which groove width and crease depth can be varied while still producing a good crease.

Use of the PATRA carton board creaser to ascertain how the creasing range changes with board type, carton size and moisture content can help many firms to develop a more scientific and less rule-of-thumb attitude to packaging problems. Speed of packing can be seriously impeded by too-stiff creases which cause bowed panels and flaps, hindering the passage of cartons through packing machines. In flow line production this can make the difference between commercial success and failure.



*The PATRA carton board creaser. A commercial version will be available shortly.*

# Fresh Water from Sea: New Evaporators

**Two new ranges of seawater evaporators have been announced. One is equally at home on land and sea; the the other caters specifically for motor ships, using the engine cooling water as the heating medium.**

DEVELOPED in parallel with the Weir " Multiflash " evaporating system, a new two-stage flash evaporator has been announced by the same company. Although it is a packaged design usually associated with marine applications, the makers say that the unit is equally suitable for land use.

## Packaged Unit for Land or Sea

Known as the " F1," of the two-stage design, the plant operates on the " once through " principle, and unlike the " Multiflash " design there is no recirculation of the seawater. It is made in three shell sizes which give a combination of five standard outputs of 20, 30, 40, 50 and 75 tons per 24 hours. Weir's figures for the output of distilled water per lb of steam used is given as 1·35 to 1.

An electric salinometer with solenoid-operated dump valve, and sea water and distilled water meters are provided. Included in the unit are brine and distilled water pumps and distiller, external feed heater and steam jet air ejector.

Of vertical design, the unit has a square cross-section, the shell being in fabricated mild steel. Internal surfaces in contact with seawater have a protective coating. All ancillaries mentioned above are either incorporated in or are mounted on the evaporator structure.

Sea water first passes through the heat exchangers "A" and " B " in the two flash chambers in series (see Fig. 2), where it is heated by the rising vapour. Receiving further heat as it passes through the air ejector condenser " C," it is finally heated using LP steam in the feed heater " D." On leaving theh eater, the feed temperature has been sufficiently raised to allow flashing to take place in the first flash chamber, where a partial vacuum is maintained by the air ejector.

On entering the first flash chamber, a portion of the feed flashes off as vapour, passes through the demister " E," and is condensed at the heat exchanger "A," giving up the latent heat to the incoming feed. The brine then passes through an orifice into the second flash chamber where the process is repeated. At the exit from heat exchanger " B " and from No. 2 flash chamber, the distillate is drawn off by the distillate pump. The brine is drawn off by the brine pump and discharged to waste, thus completing the cycle.

To prevent carry-over of water droplets with the vapour, a demister screen is employed. This is in the form of a knitted Monel metal wire mattress 6 in thick built into the upper part of each of the two flash chambers. The makers say that it operates very efficiently and because it is self draining ensures a high-purity distillate.

As can be seen from Fig. 1, the feed heater is of cylindrical shell design and sits on the top of the evaporator shell. Heated by an external LP steam supply, it is constructed from mild steel with aluminium brass heater tubes.

The steam jet air ejector is of the external diffuser type, with cast iron body and covers, gunmetal diffusers and Monel steam nozzles. Seawater fed to the plant is preheated as it passes through the air ejector condenser before entering the feed heater.

Brine and distilled water pumps are electrically driven and are of the vertical centrifugal type. Squirrel cage drip proof motors comply with Lloyd's requirements for use on ships in tropical waters. Sea water and condensate pumps can be had as extras.

A pressure of 15 lb per sq. in is needed for the seawater supply, and the quantities required are given in the accompanying table.

| Unit | Seawater per hour | |
|---|---|---|
| | Imp galls | Cu. metres |
| 20T | 3,850 | 17·5 |
| 30T | 5,775 | 26·25 |
| 40T | 7,700 | 35·0 |
| 50T | 9,625 | 43·75 |
| 75T | 14,425 | 65·56 |

Condensate drains from the feed heater need to be led to a point of higher vacuum or an extraction pump.

Of standard design, the salinometer is relayed to a solenoid operated dump valve, which automatically rejects the distillate should its salinity exceed 2 ppm (0·15 grains of chlorine per gallon).

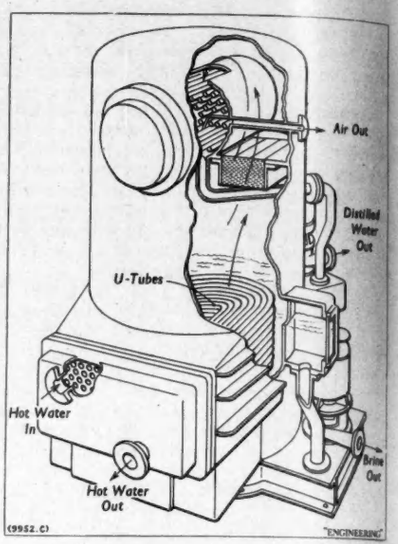



*Fig. 3 Specially designed to provide fresh water supplies on motor ships, the " D1 " evaporator utilizes the waste heat from the engine cooling water for heating the seawater.*

Flow meters indicate the feed and distillate flow rates, the two meters being of the direct reading type. All the instruments are mounted on a single panel at the front of the plant.

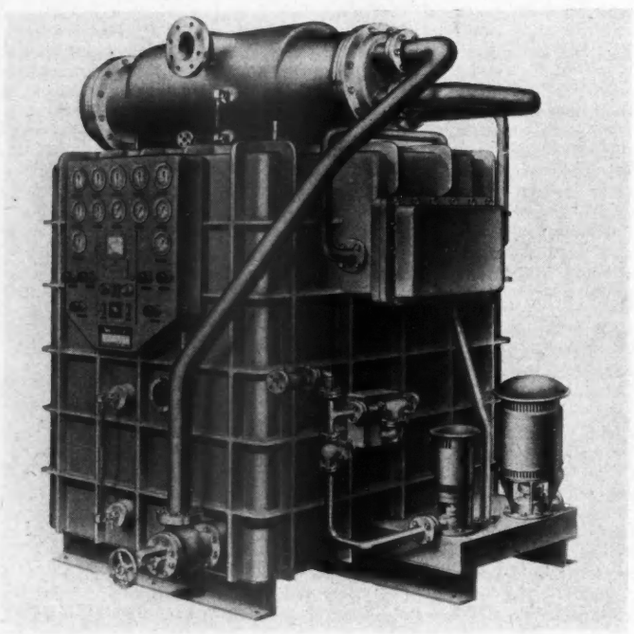
## Waste Heat Evaporator for Motor Ships

Another evaporator available from Weir's is the " D1 " waste heat type, designed to provide a plentiful supply of fresh water on motor vessels —where the steam supply is limited.

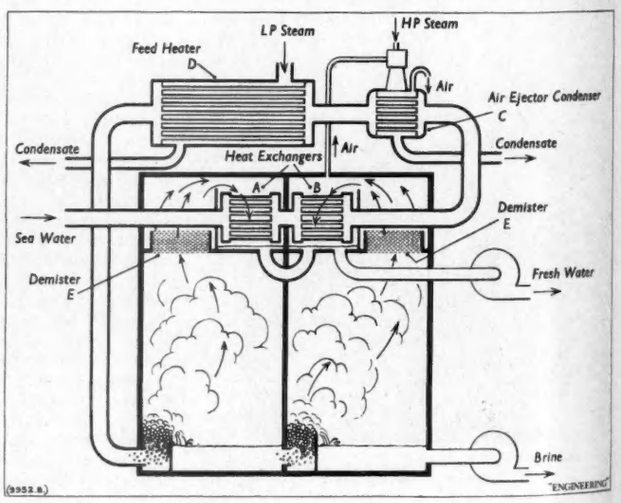
Shown in Fig. 3, it is a simple automatic unit of the submerged type and uses engine cooling water as the heating medium. The usual range of ancillary equipment is fitted and salinity indicator and circulating pump are extras.

Of vertical cylindrical design, it is made in a range giving standard outputs of 5, 10, 15, 20, 25 and 30 tons per 24 hours. The sea water is circulated through immersed U tubes.

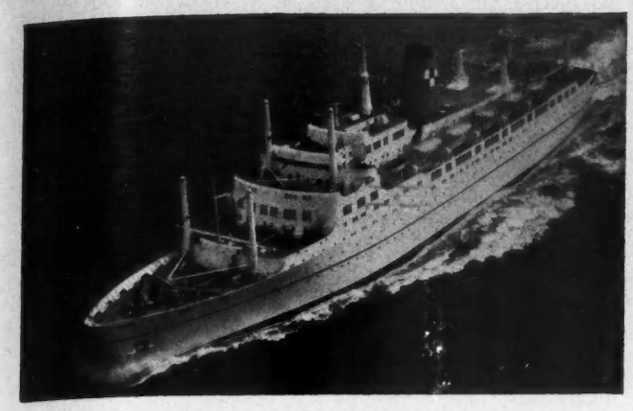
*G. and J. Weir Limited, Cathcart, Glasgow, S4.*



*Figs. 1 (left) and 2 (below) Although of the packaged design usually associated with marine applications, this two stage flash evaporator is equally suitable for use in land installations. Developed from the Weir " Multiflash " system, the " F1 " as it is called is made in five output sizes ranging from 20 to 75 tons of fresh water per 24 hours.*



# Ocean Going Liner Built for Navigating a River



*Scantlings of the hull frame and the shell in the forward parts of the Empress of Canada about the waterline have been increased as stiffening against ice, a hazard in the North Atlantic crossing. Fire protection goes beyond the statutory requirements and the rudder control mechanism gives quick manoeuvring for passage up the St. Lawrence.*

The 27,300 ton Canadian Pacific liner Empress of Canada, which left Liverpool on her maiden voyage last Monday, is the largest ship built to go up the St. Lawrence as far as Montreal.

Total mileage from Liverpool to Montreal via Cape Race is approximately 2,900 miles and the portion of the journey which involves river work is from Belle Isle to Montreal—a distance of about 857 miles. Thus, a large portion of the vessel's time is spent in the St. Lawrence and, in view of the necessity for good handling in navigating the river, special attention has been paid to the rudder design to ensure good manoeuverability at low speeds.

In addition to incorporating several minor improvements on the rudder and stern frame shape, as compared with earlier vessels, the builders also provided an unusually large rudder area for this size of ship. During the course of trials, special measurements were taken to determine the efficiency of the rudder ano the steering gear, including turning circle trials and manoeuvres over a wide range of speeds.

These trials and the general handling of the vessel showed that she is capable of being steered on a straight course with only a few degrees of rudder movement.

Steering gear is by Brown Brothers and is of the four ram type having two power units, each consisting of a variable delivery pump direct coupled to a 80 hp electric motor. With one power unit in use the gear can move the rudder from hard-over to hard-over (70°) in 30 sec with the vessel moving at full speed ahead, or 18 sec with both units in use.

**Details of "Empress of Canada"**

| | |
|---|---|
| Gross tonnage | 27,300 tons |
| Length | 650 ft |
| Breadth | 86 ft |
| Draft | 29 ft |
| Service speed | 20 knots |
| First class passengers | 192 |
| Tourist class passengers | 856 |
| Crew | 510 |
| Builders | Vickers-Armstrongs (Shipbuilders) Limited |

When manoeuvring both power units are used, but in open waters only one pump is operated. Pumps and ram cylinders are so interconnected that both pumps may be running together or independently on five combinations of cylinders. The steering gear is controlled by a Duplex telemeter installation.

The North Atlantic run imposes severe conditions on a ship and the Empress of Canada has been constructed to the latest Ministry of Transport requirements for foreign-going passenger liners and also to the highest class of Lloyd's Register of Shipping. Much model research was done in testing tanks to determine the best underwater form for the vessel and a bulbous bow has been incorporated in the hull design to reduce the pitching effect. Rolling is practically eliminated by the fitting of Denny-Brown stabilisers.

Although the superstructure is somewhat higher than that of the Empress of Britain and the Empress of England, its silhouette is low in comparison with vessels of equal size and tonnage.

Structural design involves a combination of longitudinal and transverse framing employing a large amount of welding. In addition the sheerstrake and two strakes of plating about the waterline are of special welding quality steel, and the scantlings of the frame and the shell forward have been increased for stiffening against ice.

All decks are welded, the beams being angles with continuous full welds, except at the promenade deck and above where the beams are intermittently welded. Special attention has been given to the pillaring arrangements, and in view of the high stress involved an expansion joint has been incorporated in the superstructure.

The sad fate of the previous Empress of Canada which caught fire in Liverpool docks some eight years ago seems to have had some influence on the design of the new vessel. She is fitted out in excess of Ministry of Transport and Convention requirements in respect of fire protection and fire appliances. In addition to being subdivided into zones by fireproof divisions, it is equipped with Grinnel automatic sprinkler, and fire detection and alarm system in the accommodation and service spaces. In cargo spaces a Pyrene smoke detecting/$CO_2$ fire extinguishing installation is fitted. In the boiler room and the auxiliary machinery room there is a separate installation of $CO_2$ equipment with high and low level supplies.

The central fire-control station in the wheelhouse incorporates the alarm indicators—the smoke detecting cabinets giving audible and visual signals—and stop switches—for main fans as well as alarm bells and telephones.

The vessel is propelled by twin screws, the power being provided by two independent sets of double reduction geared turbines of Pametrada design, working on a reheat cycle. The machinery is designed for a service shp of 27,000 and a maximum of 30,000 with propeller revolutions of 123 and 127 per minute respectively.

Steam is supplied by two controlled superheat and one reheat Foster Wheeler boilers each having a working pressure of 650 lb per sq. in and steam temperature of 850° F, both at superheater outlet.

Electrical power is provided by two 1,200 kW turbo-generators at 225 V and three 500 kW diesel generators, all supplied by W. H. Allen.

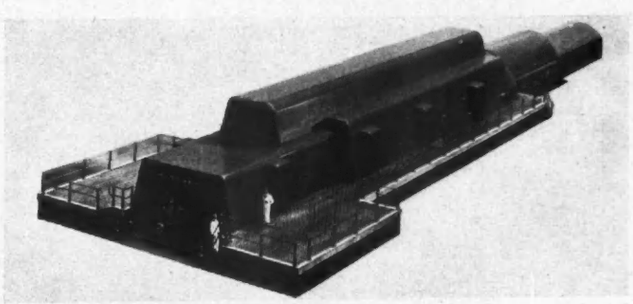
# More Turbo-generators for the Large Power Stations

The recent announcement by the CEGB that they have ordered four 500 MW single-line turbo-generators from Parsons, continues the Board's policy of building larger and more powerful coal-fired power stations to be commissioned in 1965 and later.

These new units—for a site not yet disclosed—bring the total Parsons have on order of this capacity or larger to six.

Parson's new tandem compound machines will each comprise a single line of turbines operating at a steam pressure of 2,300 lb per sq. in, at 1,050° F with reheat to the same temperature and driving a hydrogen/liquid cooled 500 MW generator at 3,000 rpm.

To obtain a thermal inertia comparable to that of the casings, assisting in rapid starting and loading, a hollow construction of both the hp and intermediate pressure turbine shafts is used. Two steam chests each containing two emergency stop valves and two governor valves will be arranged one on either side of the hp turbine. Intercept valves will be fitted in the steam lines between the reheater and the ip turbine, with reheat emergency stop valves as an additional safeguard.



*A model of one of the four single-line 500 MW turbo-generators which Parsons are to supply to the CEGB for a site not yet disclosed.*

Each generator will have a rating of 588 MVA, at 0·85 power factor, generating at 22,000 V. The rotors will be of the direct cooled type operating in hydrogen with a pressure range of 45 to 60 lb per sq. in. Direct cooled windings will be employed on the stators, using demineralized water as the cooling medium. With these methods of direct cooling for both the rotor and stator windings, together with other developments in the design, it is possible to obtain outputs of 500 MW from a frame size within the limits imposed by transport.

*C. A. Parsons and Company Limited, Heaton Works, Newcastle upon Tyne, 6.*

# On the Shelf

*By Frank H. Smith*

HAD a nice bit of backchat with a young lady library assistant at New Malden recently. (She doesn't read ENGINEERING, so I am safe.) Having borrowed a book from my library, she rang and asked for an extension. I said all right, but tell the borrower to get cracking and get it back within a fortnight. Whereat the saucy wench said " When we borrow through the NCL we allow a month." " That be damned for a joke," says I, " you borrow it from us because it is probably the only copy in the country and then you let any Tom, Dick and Harry borrow it for as long as he likes." But for once I'd met my match for crust and effrontery: she replied " What's the good of a book if it's stuck on your shelves? " After this I barely had the strength to point out that if we were as free and easy as all that with our books there wouldn't be *that* copy available (as it happens, it was a book that I had had to hunt through the *Clique*). But I let her have her way.

Ever heard of Uddeholm? No? Well, it's one of the largest companies in Sweden (ore, forest, water-power) and their Birmingham office have sent " us " (that means ENGINEERING, as opposed to me) a copy of the house prestige publication *Uddeholmaren*. It's good, even though a bit serious and one-track by some standards for such things, and anybody can have a copy by writing to Uddeholm Limited, Crown Works, Northwood Street, Birmingham 3. I still put Whitbreads top of the class in this field. Maybe because I like horses.

From the National Academy of Sciences (2101 Constitution Avenue, Washington, 25) comes a sample of Volume 1, No. 1, of the abstracts journal *Environmental Effects on Materials and Equipment*. I think you may be able to get at least the explanatory letter from C. J. Wessel, Director, Prevention of Deterioration Center, at the above address. The sub. is $25 a year.

Perhaps because it is from the German Democratic Republic, it has taken five years for me to see an issue of *CDR Review*, published by Society for Cultural Relations with Foreign Countries, Berlin W8, Thälmannplatz 8/9. It comes in German, English, French, Spanish, Swedish and Finnish. It is a " way of life " journal but I cannot find the sub. so you must write yourself and find out.

The American Society for Testing Materials has got out its list of National Meetings up to 1968. This is not so ambitious as it might at first sight appear since ASTM has only one national meeting for each year, except for '62 and '65 when there are also Pacific Area Meetings.

A quick look at the development of electric motors and generators is provided in a booklet —beautifully produced—from Pinchin Johnson & Co., 4 Carlton Gardens, London, SW1, and called *The Evolution of Electro-magnetic Machines*, by Dr. E. Kuffel of Manchester College of S. & T. It is intended as a give-away at Earls Court but I expect P. J. will have a few on their hands. Funny—I thought they were paint people.

I have no accompanying letter but I can guess at whom the National Physical Laboratory is aiming a rather elaborate booklet entitled " The National Physical Laboratory Offers Opportunities for Research in . . ." but instead of the dots there is a list of over 20 high-falutin' backroom subjects. This booklet is meat and drink to long-term viewing careers masters and I suppose they can get it from N.P.L., Teddington, Middlesex.

Hypnopaedia is the assimilation of knowledge by people while they are asleep—so why should lecturers worry? According to *Soviet News*, Professor Svyadoshch of the Karaganda Institute in Kazakhstan has written a book *Assimilation of Speech during Natural Sleep*, which strikes me as a nice restful way of doing it.

# Tractive Effort for Modernization

**Railway Locomotives.** By JOHN R. DAY and B. K. COOPER. *Frederick Muller.* (9*s* 6*d*)
**British Locomotives.** *Locomotive and Allied Manufacturers' Association, Locomotive House, Buckingham Gate, London SW1.* (15*s*)

The revolution which descended on British Railways under the more congenial name of the modernization plan was long to be foreseen and long overdue. However, once the technical possibilities had been correctly interpreted and the money necessary to implement the conclusions had become available the revolution took place—as decreed from above.

In the outcome, and in common with most revolutions, the old order became somewhat ridiculous and at least slightly contemptible with the young, while the old and elderly could scarcely hide a feeling of nostalgia for the good old times full of steam clouds, loud noises and heroic deeds of drivers, firemen and their noble steeds, appearing in all colours of the rainbow. The pictures of the outstanding locomotives of the old regime are slowly disappearing from office walls in favour of the new, less romantic but more effective representatives of motive power.

The pattern is a familiar one, not confined to politics alone. The increased effectiveness of the new power units has been obtained at the expense of increased complexity and a demand for close cooperation with manufacturers in such specialised fields as diesel engine and electrical equipment. This evolution in turn demands clear and unambiguous appreciation of the requirements which must be imposed on the new locomotives as traction machines required to produce ton-miles in a most economic manner, in other words, the best matching of engine performance and fuel consumption to the most prevailing traffic requirements, the correct choice of transmission characteristics, the choice of motor characteristics with regard to traffic demands and with particular reference to adhesion and the tendency to wheel spinning.

That weight is assuming increasing importance need scarcely be mentioned; the overall economics make this trend clear, and the possibilities offered by ever increasing power outputs of the prime movers, the use of light alloys and plastics and careful design spur on to further efforts in this direction.

The necessity of using wheels of smaller diameters than with steam locomotives, of bogies with primary and secondary suspensions, of keeping weight transfer and tyre wear down, presents new design problems. Here it is essential to appreciate clearly the implications of fundamental mechanics and of the results of extensive research relating to the statics and dynamics of wheels running on straight and curved track as evolved mainly by Heumann, de Pater, Müller and van Bommel.

This deeper understanding means that the emotional approach to railway engineering as often exemplified by the treatment of the steam locomotive in a large sector of the contemporary semi-technical literature must give place to a clear explanation of the reasons for certain design practices and also of the pitfalls which should be avoided. Similarly the steps required to ensure optimum results should be stated against the background of mechanics, electricity and thermodynamics; the close relation between these and successful designs should be stressed; and the poor results caused by deviations and lack of understanding of fundamental considerations should also be mentioned.

The first of the two books considered here belongs to " a series of books presenting introductions for young enthusiasts." Its professed aim is " to state the basic principles on which most locomotives work." This approach made the inclusion of the steam locomotive essential and the chapters devoted to it are perhaps the most clear and lucid of the book. The case for the diesel is made mainly on the improved fuel efficiency, whereas the overall effectiveness is also appreciably increased by the reduced locomotive weight and reduced maintenance requirements. On the other hand, " the exhaust of diesels, despite the arguments you may have heard about it, is considered more or less harmless " —whatever that might mean. The reference to two and four stroke diesels could be amplified to explain why both exist and why the latter predominate, at least in Europe.

The reader would no doubt benefit from a study of curves showing power output, torque and fuel consumption which illustrate the need for a transmission and for careful engine and locomotive matching, far better than a mere word picture. The reference to specially designed fans used as mechanically driven blowers is misleading; these are centrifugal or positive displacement blowers. The speed of turbo-chargers is not a casual affair but depends on the rotor diameters since the blower tip speed should generally not exceed about 1500 ft per second.

Statements that intercooling may prove as important as the original idea of pressure-charging are meaningless. The former means nothing without the latter, and this kind of knowledge is of no value to young enthusiasts who would benefit more from a few simple numerical examples. The thermostat operating temperature stated to be only 130° F is on the low side and the statement that this is the best working temperature for the engine needs a justification and a brief but reasoned explanation.

The text could benefit from more attention to detail; thus filtration and train heating requirements (steam or more recent electric supply) and engine rating should be considered, rather than mentioned in passing. The gas-turbine locomotive is described in a few paragraphs without the aid of a single diagram but with the aid of such a statement that " a pulverized-coal burning turbine may yet sweep the field in Britain and Europe." The free-piston engine also receives mention but no sketch to explain it. The mechanical transmission is described in words but again a simple diagram augmented by tractive effort vehicle speed curves would make for a better understanding. The same goes for the Fell locomotive which develops its maximum tractive effort (not power) using only one engine.

When it comes to hydraulic transmissions it is quite wrong to say that they can sustain high tractive effort at low track speeds with more success than the electric systems, the constituents of which tend to heat up rapidly under such conditions. Reference to electric locomotive performance will immediately show how wrong such sweeping generalisations can be. The initiator of the fluid flywheel and the hydraulic torque converter, the late professor of hydrodynamics at Berlin, is mentioned as " a deceased German inventor named Föttinger." The list can be augmented further, and the book shows signs of being completed in somewhat of a hurry.

No book of this type should omit mention of the five British Railway diesel locomotive types and it would benefit from tabulated engine and locomotive data, which of course require painstaking correlation of widely scattered information. The mechanical aspects of locomotive design and the reasons behind certain practices are conspicuous by their absence; only the unusual SNCF *monomoteur bogie* is illustrated in some detail. However, the illustrations used to show representative locomotives are well chosen and the good work done by the British Transport Commission Design Panel on the alternating-current electric locomotive is clearly shown when compared with the French or Belgian machines.

The book suffers from an apparent desire to put in too much of what often amounts to rather subsidiary information, of using words rather than explanatory diagrams and of foregoing the fundamental and general for the sake of the particular. More could have been accomplished

within the available space, particularly since the print is large and clear and can be easily read at a distance of 3 ft. It is suggested that a book destined for the particular class of readers should above all bring out the fundamentals which matter and which must be adhered to, and the requirements which must be met to make the railway locomotive a successful producer of ton-miles.

Such a treatment would call for considerations of tractive effort, tractive resistance and fuel consumption characteristics at full and part loads, of design principles and limitations always referred to fundamental considerations. This approach does not require mathematics but it does demand more than a nodding acquaintance with traction mechanics and design aspects of such highly developed machines as modern diesel and electric locomotives. The book has a table of contents but it would also benefit from an index or bibliography. The absence of a bibliography in a book destined for young readers is particularly regrettable since they might be expected to require careful guidance through contemporary literature.

The magnificent volume produced by the Locomotive and Allied Manufacturers' Association has fully met its objective to show the scope of achievement of one of the country's oldest, most successful and most popular industries. The text and particularly the well chosen and beautifully reproduced illustrations do full justice to the technical excellence of the industry's products, while the matchless simplicity of the 4-2-2 express locomotive of the Caledonian Railway is at least in the outward form resurrected in the appearance of the BR Bo-Bo ac electric and the type 2 AIA-AIA diesel-electric locomotives. The contribution of the industry to the modernization plan, the clear and simple expositions of diesel and electric locomotive fundamentals, a brief history of the industry, its contribution to overseas and industrial railways, combine to make this attractive publication a source of joy to railway engineers and their families.

Both books are representative of the prevailing trend of railway publications in this country—a generalised descriptive text, not unduly deep but, rather, spreading over a wide area on the one hand, and the luxurious presentation volume on the other. It addition there is the historical literature about antique locomotives, titled trains, old railways, train races and so on, which is assuming flood proportions at the expense of the more strictly technical literature, which does of course take more time and effort and is possibly less lucrative in the end.

But the motive power revolution urgently demands serious technical textbooks which must be made available to engineers on the railways and in the industry if these are to be kept in the forefront of modern development, embracing such specialised fields as traction mechanics, as well as diesel and electrical engineering, and if young men are to be attracted by railways instead of by the glamour of electronics and astronautics.

The necessity has been clearly recognised in Russia, which now publishes a large number of excellent textbooks on such specialised subjects as electric traction, overhead structures, electric locomotives, multiple-unit stock, diesel locomotives, transmissions, stressing or carriages and wagons, dynamics of vehicle running and a spate of texts on railway economics and operation. The German industry before the war published a number of texts of high standard mainly devoted to electric traction as well as general motive-power pocket books. These publications dealt with theory and practice (construction and maintenance); they helped the reader and *inter alia* the sponsoring organization.

However, relatively little has appeared since the war, the outstanding exceptions being two volumes on railway operation by Müller and two monumental volumes on all aspects of electric rolling stock theory and design by Professor Sachs, who with the aid of others is now preparing a third volume. The publication of these volumes has been sponsored by the Swiss authorities and the industry, thus making the price accessible even to young engineers.

In this country we had the benefit of some very good texts on electric traction notably by Dover and by Ferguson, but even so the various aspects of diesel and electric traction have become so highly specialised that they could scarcely be done justice by one man alone. The appearance of rigorous and thorough textbooks dealing with the complexities of railway mechanics, with diesel and with electric traction is long overdue. To meet this demand British Railways and industry's engineers might share their knowledge and experience by writing authoritative texts as a joint venture for the benefit of their profession.

J. L. KOFFMAN

# First Hardships then the Stars

**Engineering: The Profession and Elementary Problem Analysis.** By H. W. LEACH and GEORGE C. BEAKLEY. 2nd Edition of "Elementary Problems in Engineering." *The Macmillan Company, New York and London.* (37*s*)

In the short space of 394 pages this book gives a quick historical survey from the pyramids of Egypt as ancient engineering feats right through to nuclear engineering. It embraces topics ranging from how to hold a slide rule between one's fingers to the concept of imaginary numbers. Such is the breadth of this recruitment handbook to the engineering profession. But those who expect from the title a useful guide for sixth formers or first year undergraduates on engineering as an intellectual discipline or even as a rewarding career are advised to put it down. It is not for them. What it does do is to show the scope and excitement of an engineering career, while not concealing the laborious foundation that must first be laid.

This is an American book and is mainly related to the United States educational system. That system has its limitations like all others and one of them is often lack of intellectual depth in 'teen-age curricula. The best that the United States produces is among the best in the world but many high-school curricula are strewn with intellectual bric-à-brac.

The book may well be intended to make an impact on youngsters who are good potential material at high-school level and are getting a grip of mathematics after a slow start. Their imaginations need a boost as well. Illustrations of imaginary freight transports landing on the moon are only a few pages away from graphs drawn to logarithmic scales. The book is saying to American youth: would you like to be an engineer? It offers lots of scope. If you do, these are the kind of things you will need to know—do you think you can make it?

Viewed in that light, one can tuck away one's intellectual snobbery and grasp the point of the book. It is in any case the work of a partnership, one member of it a professor of engineering. It had a previous edition called *Elementary Problems of Engineering*, and uses a simple direct style of writing.

It is of interest over here because it recognises the universal problem that many more engineers are needed, and that they have to be recruited in competition with other careers. The day is coming too when large numbers of recruits will be needed for the echelons immediately below the fully trained engineer with his academic or professional qualification—technicians to back up the technologists. The need is indeed already here and we in this country are not doing much about it. This book is part of the answer in an American context. It is therefore worth study by those who have to grapple with the problem in this country.

Three-quarters of the book are concerned with mathematics. Illustrations, often sketches, are used to help the serious minded young reader, plodding through a wide range of problems, to see the practical end of it all. Indeed, for those who take it seriously it will prove quite a formidable cramming course. Exercises in drawing in free-body diagrams are made palatable with accompanying pictures of ships, cars and locomotives.

Not everyone's method, but it may work in some cases. That is the whole point of it. Given the amount and quality of adolescent material the profession may have to handle in due course, can any one think of a better way? This book could help towards the answer.

G. E. TEWSON

# Unified Network of Knowledge

**McGraw-Hill Encyclopedia of Science and Technology.** 15 Volumes. *McGraw-Hill, New York and London.* (£75 11*s* 6*d*)

**Introduction to Mechanics, Matter, and Waves** By UNO INGARD and WILLIAM L. KRAUSHAAR. *Addison-Wesley Publishing Company, Reading, Massachusetts, and London.* (53*s*)

**Introduction to Modern Physics.** By C. H. BLANCHARD, C. R. BURNETT, R. G. STONER and R. G. WEBER. *Pitman.* (37*s* 6*d*)

**Introduction to Quantum Mechanics.** By ROBERT H. DICKS and JAMES P. WITTIE. *Addison-Wesley Publishing Company, Reading, Massachusetts, and London.* (66*s*)

If the advertisements for encyclopaedias are to be believed it is the purpose of such books to raise the income of the breadwinner in accordance with an exponential law, to enable mother to knit Fair-Isle jumpers, grand-dad to grow prize dahlias and the children to become well-educated citizens of a model democracy. Alas, experience does not bear out these proud claims. The children will indeed use the encyclopaedia, but their interest is more likely to centre on the facts of life than on citizenship, and father's income will remain as before.

This is not to say that there is no value in an encyclopaedia such as the new McGraw-Hill *Encyclopedia of Science and Technology*. Quite the opposite, there is enormous value in it and great pleasure can be derived from spending one's leisure hours browsing among the contents The production is excellent with a clearly printed text and large numbers of diagrams and other illustrations. The price rules out private possession of these books, but it is to be hoped that the larger public libraries will purchase a set.

Like other such work this encyclopaedia is unsuitable as a textbook or as an aid to passing examinations; its real value lies in presenting a general introduction to a large number of topics. The title of the McGraw-Hill encyclopedia is slightly misleading, because it contains relatively little technology, at least in the two volumes seen by the reviewer. No doubt the publishers found it easier to obtain contributions from universities than from practising engineers.

The title of Ingard and Kraushaar's work seems to presage a muddled book: mechanics, matter and waves are an ill-assorted set of notions. To the student of the American educational scene, however, this title is full of significance. Here is another in a series of books, most of them written by the staff of the Massachusetts Institute of Technology, which attempts to draw together various branches of engineering science into a unified whole. These books are a result of a strong reaction against the fragmentation of knowledge which has been practised in the American universities for many years.

The present tendency is to try to discover common principles running through all the branches of engineering and it has been found that mechanics can be used as a unifying influence. Thus this book deals with the mechanics of particles and rigid bodies, with thermodynamics, kinetic theory, mechanics of fluids and stress waves. The result is an interesting work which should be studied seriously by university and technical college teachers.

Not everything that comes across the Atlantic is worthy of imitation but engineering teachers in this country should pay attention to the great effort that is being put at the present time into the improvement of teaching in the United States. It is distressing to note that many of the British leaders of educational policy are urging increased specialisation of subject matter and the setting up of small autonomous groups just at the time when our American friends have realised the unsatisfactory nature of such a system.

*Introduction to Modern Physics* is exactly what it says. The treatment is almost entirely descriptive and the book is probably too superficial to be of use to students taking courses in physics. On the other hand, the book is likely to be of help to engineers who during the course of their work meet such terms as "the Schrödinger wave equation" or "the Lorentz transformation" and want to find a short non-mathematical account of these topics. Unfortunately, the book deals hardly at all with engineering applications and the amount of discussion given to a topic bears no relationship to its importance to engineers. Nevertheless, it is a useful book and gives a clear introduction to nuclear physics in general, to quantum theory and to restricted relativity theory.

Those who want to study quantum mechanics in greater detail will find *Introduction to Quantum Mechanics* a useful volume. This is not an easy work and demands from the reader a good grounding in physics and mathematics. It is aimed at post-graduate students, but is also likely to appeal to research workers looking for a coherent account of this important branch of physics. It should perhaps be pointed out that the authors restrict their treatment to non-relativistic quantum mechanics.

P. HAMMOND

# Main Lines and Branch Lines in Perspective

**More Unusual Railways.** By JOHN R. DAY. *Frederick Muller.* (21*s*)

**World Railways, 1960.** 6th Edition. Edited by HENRY SAMPSON. *Sampson Low, Marston and Company.* (10*s*)

**Railwayman.** By CHRISTOPHER VINCENT. *Lutterworth Press.* (10*s* 6*d*)

Railways may be in the red, branch lines all around are being closed, well-intentioned people are anxious to replace rail by road—but the flow of railway literature continues unabated. Every facet receives attention and the three books mentioned above treat of railways past, present, and to come.

Both past and present, and possibly also the future, are combined in *More Unusual Railways*, which deals with some of the many attempts to improve on the existing means of locomotion, forms of track, or both combined. Some of the schemes described—perhaps fortunately—never left the drawing board. Others ended in a blaze of glory, if a boiler explosion may be so described.

All are of interest to the student of railways but, in addition, the book contains much of value to those concerned with today's transport problems; for, in conjunction with the material contained in its companion volume, *Unusual Railways*, it give an almost complete survey of monorail and guide-rail systems. Monorail systems, both supported and suspended, are receiving world-wide study and their protagonists claim that they are the answer to many urban and suburban traffic problems, as indeed they may well prove to be.

Moving platforms, also associated with modern travel, are included, and as is so often the case with "modern" developments the reader learns that they were in fact introduced many years ago. This book will appeal to all those conconcerned, professionally or otherwise, in the planning of rail transport, for it is an excellent survey of some of the most-up-to-date developments blended with much of great historic interest.

The present is admirably covered, in much detail, by *World Railways*, which has achieved a great reputation as a source of information of almost every kind on railways everywhere. The present edition, which has been completely revised and reset, falls into four sections. The first of these gives particulars of the physical characteristics of railways, particulars of their motive power and rolling stock, operational results, and other relevant data. Among the information provided are particulars of temperature and humidity, matters of considerable concern to suppliers of diesel locomotives.

The second section gives details of 125 major railway systems and 220 locomotive and rolling stock builders, situated in every continent. Railways today are interwoven with national economy as never before, it is therefore fitting that this section contains information on economic positions and trends.

Section three gives details of 33 underground railways, while the fourth section gives specifications and illustrations of rail-traction diesel engines which are available from 50 of the world's principal engine builders.

This volume is unique in the great amount of information which it contains. Having regard to its comprehensiveness, and the immense amount of work which must be involved in its compilation, the price may be regarded as a moderate one. Certainly the information it contains will be worth far more to many people, and equally certainly it lives up to its subtitle of "a worldwide survey of railway operation and equipment."

*Railwayman* may be said to refer to the future, in that it is described as a "picture—career book," and refers to the opportunities in a modern railway system. It nevertheless contains many illustrations from the past and the heritage of railways forms a large proportion of the contents. The story is told from the earliest days and leads on to what modernization holds for the future. It may help to influence some boys in the choice of their career. Should a further edition of this book appear it is suggested that some of the captions could be phrased more accurately.

C. R. H. SIMPSON

## Trade Publications

*Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.*

*Activities*

**Plant Construction.** PARSONS POWERGAS, 15 Portland Place, London W1. Complete construction services for the petroleum and petrochemical industries. Examples all over the world. Brochure. 16 pp., ill.

**Wire Rope Spooling.** WOODFIELD ROCHESTER LTD., Frindsbury Works, Rochester, Kent. The LeBus system of controlled multi-layer wire rope spooling, described with examples in brochure. 12 pp., ill.

**Data Processing.** E.M.I. ELECTRONICS LTD., Hayes, Middlesex. Six typical uses of the Emidec 1100 data processing equipment described in three colour brochure with flow charts. 30 pp., ill.

**Electronic Equipment.** ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY) LTD. Industrial electronic equipment, motor control, switching regulators, timers, heaters, etc., outlined in broadsheet in colour. 8 pp., ill.

**Products for Railways.** STANDARD TELEPHONES AND CABLES LTD., Connaught House, Aldwych, London, WC2. The firm's products for the railways of the world. Telecommunication, remote control, teleprinters, cables, computers, heat treatment plant, etc. Catalogue-brochure. 116 pp., ill.

## New Books

**Transistor Circuit Analysis.** By MAURICE V. JOYCE and KENNETH K. CLARKE. *Addison-Wesley Publishing Company, Reading, Massachusetts, and London.* (81*s*)

After more than five years of large-scale use of junction transistors, the authors have felt the time ripe to consider the most profitable basic methods of analysis. Their text draws upon graduate courses at the Polytechnic Institute of Brooklyn.

**Understanding Organisational Behaviour.** By CHRIS ARGYRIS. *Tavistock Publications.* (38*s*)

Professor Argyris begins by presenting a theoretical framework designed to make possible the accurate diagnosis of complex organisations, and goes on to consider research procedures, and to apply them to a hypothetical case study.

**Mechanised Cutting and Loading of Coal.** By R. SHEPHERD and A. G. WITHERS. *Odhams Press.* (50*s*)

Following an historical review of the subject, the authors describe and illustrate the principal British and foreign machines of each type. Later chapters cover safety and health aspects, design and operational problems, and possible future developments.

**Mechanical Waveguides.** By MARTIN REDWOOD. *Pergamon Press.* (50*s*)

In much of the research work in which mechanical waveguides are found, the waveguide itself is only of subsidiary interest, the researcher's specialised knowledge being in chemistry, physics, metallurgy or some branch of engineering. Accordingly the present book sets out to be an introduction to the properties of guided waves, together with a survey of recent research.

## The Reviewers

Mr. J. L. Koffman, Dipl. Ing. (electrical), M.I.Loco.E., is design engineer (projects) in the Chief Mechanical Engineer's Department of the British Transport Commission.

Mr. G. E. Tewson, M.A., is a graduate in economics of Glasgow University, former editor of a business magazine, and now a partner in the firm O. W. Roskill Industrial Consultants.

Mr. P. Hammond, M.A., M.I.E.E., A.M.I.Mech.E., is university lecturer in engineering in the University of Cambridge.

Mr. C. R. H. Simpson, Assoc.I.Loco.E., is on the editorial staff of the *Railway Gazette* and was until recently assistant to the technical sales manager of Beyer Peacock Gorton Company Limited. Author of sundry books and over 2,000 articles on locomotive practice, he has also been editor of *The Locomotive Railway Carriage and Wagon Review.*

# Marketing

## Success from an Ulster Factory

THE four positive advantages that CAMCO Incorporated, of Houston, Texas, found when they opened a new factory in Northern Ireland were the ready availability of labour, the free cooperation of the Ministry of Commerce, a happy reception and excellent conditions.

The Camco factory, at Carnmoney, near Belfast, employs 60 people in the production of gas-lift valves and allied equipment for the oil industry. Speaking at the ceremony to mark the official opening of their works, Harold E. McGowen, Jr., president of Camco Incorporated, said:

"If we again had the choice of placing a plant in any part of the world, we would again choose Northern Ireland."

The 18,000 sq. ft factory was formally declared open by Lord Glentoran, leader of the Northern Ireland senate.

The operation of bringing Camco to Northern Ireland and their opening a works there seems to have gone like clockwork. The Ulster authorities first heard that Camco were looking for factory space in July, 1958. A suitable factory was almost complete and Camco sent in proposals in August, moved into the factory in November, began assembly in December and in January, 1959, the first items were coming off the production line.

To Northern Ireland the value of Camco is out of proportion to its size. Its output is exported, it brings diversification to the Northern Ireland industries and its employees are all men.

## Electronic Component Agreement with Italy

Under the terms of an agreement concluded with RINI INTERNATIONAL, of Milan, the PLESSEY Company are to manufacture Rini thermal overload protectors and starting relays, with exclusive marketing rights in the United Kingdom and non-exclusive rights elsewhere except in Italy.

Plessey, a major part of the electronic component industry of the United Kingdom, will expand its interests in the refrigerator component field as the result of this agreement. ELETTROTECNICA RINI SpA are one of the leading manufacturers of protectors and relays in Europe. Their comprehensive range includes patented relay-protectors combining the features of overload protection and relay control in a single unit.

## Polythene Plants for East Europe

SIMON-CARVES, part of the SIMON ENGINEERING GROUP, have contracted with an East European consortium to design four polythene plants to be built during the next three years. The members of the consortium are Poland, Romania, Czechoslovakia and Eastern Germany.

IMPERIAL CHEMICAL INDUSTRIES were also concerned in the negotiations in London. ICI have reached agreements with the same countries by which certain technical information on the manufacture of polythene becomes available to them.

All the specialized equipment involved in the £7 million Simon-Carves contract is to be produced in the United Kingdom. Simon-Carves engineers will assist in the erection and starting up of the plants.

## Radar Display Units for Brussels State Airport

Brussels national airport is to have 18 fixed coil radar display units made at the Chelmsford works of MARCONI'S WIRELESS TELEGRAPH Company. The order was placed with Marconi's and the SOCIÉTÉ ANONYME INTERNATIONALE DE TÉLÉGRAPHIE SANS FIL ELECTRONICS, of Brussels.

A new 500 kW Marconi 50 cm surveillance radar is nearing completion at Brussels airport. When the 18 radar display units are installed Brussels will have one of the most comprehensive display facilities installed on any continental European airport. A complete coverage far beyond the Belgian borders will be available to the air traffic controllers.

Facilities for data handling of radar information will be progressively incorporated.

Marconi's connection with RÉGIE DES VOIES AÉRIENNES goes back a number of years. Several 50 cm radars have been installed and recently the S264 50 kW radar installation at Brussels airport was completed by the addition of a Marconi video map system.

When the airport's radar installation programme is complete, Belgium will be among those few countries providing full radar cover over the whole territory and substantially further from the base in all weather.

## The Mighty Range of AEI at Moscow

Models of the P & O liner Canberra and the de Havilland Trident jet aircraft will appear on the ASSOCIATED ELECTRICAL INDUSTRIES' stand at the British Trade Fair in Moscow next month, in partnership with a model from the Turbine-Generator division of AEI recalling wartime cooperation with the Soviet Union.

Canberra and the Trident are there because AEI played an important part in their creation. The wartime cooperation was with mobile power stations, 35 of which were made by Metropolitan-Vickers. These had first been designed when there was a possibility of British power installations being seriously damaged. They were redesigned for use on the Russian railways and shipped out to Russia by the Ministry of Supply. The 35 stations, ranging from 1 to 5 MW and with a total output of 101 MW, reached the Soviet Union when the problems of reconstruction after liberation were at their most difficult.

The model to be shown in Moscow is one of a 5 MW set with an oil fired boiler. Among those which were sent were coal and oil fired 1 MW units and 2½ MW coal fired units.

First designed for mounting on barges or road wagons in the United Kingdom, their designs were altered to allow for use on rolling stock, bearing in mind the track gauge and generous loading gauges of the Russian railways. The power trains were hauled slowly by locomotives and shunted to positions near water supplies. Steam and electrical couplings between tracks were completed and operations reached efficiencies comparable to permanent stations of equal capacity. Some mobile power stations were being produced when the war ended and these were sent to Egypt, Iran and China—and in Spain they provided portable power for the wine making interests.

A more recent piece of cooperation concerns the AEI MS7 mass spectrometer. The Russians have ordered two of these for nuclear research purposes. One of them will be in use on the stand.

The first mass spectrometer using a spark source to be made commercially available, this is the most advanced of its type and has a sensitivity allowing for detection of one part (atomic) in a thousand million. Also from the AEI Instrumentation Division will be vacuum pumps and Pirani gauges.

Three locomotives made by AEI's Traction Division which have earned major orders for the group will be shown in model form. They are:

The 3,000 V, 2,280 hp electric locomotive for the SOUTH AFRICAN RAILWAYS. 135 of these have been ordered and so far 124 have been shipped.

The 1,500 V, 3,280 hp electric locomotive for the NEW SOUTH WALES GOVERNMENT RAILWAY. AEI have supplied 40 of these.

The 25 kV, 3,300 hp ac locomotive for BRITISH RAILWAYS. Of these AEI are supplying 35, with 40 sets of electrical equipment for similar railway built locomotives.

Russian housewives visiting the Sokolniki Park where the exhibition will go on from 19 May to 4 June will find AEI showing their GALA refrigerators, washing machines and other domestic equipment. For the Russian who has travelled, or who aspires to do so (by sea rather than space) the AEI true motion Escort Marine radar will be given a special display. Radar of this type is fitted in the Queen Elizabeth and Queen Mary and is being installed in the CUNARD passenger liners Saxonia, Ivernia and Carinthia.

AEI will be staffing its Moscow stand, one of the largest at the Fair, with a hand picked range of executives with special knowledge of the group's products, from transistors, thyratrons, magnetrons and heavy current ignitrons to under-sea power cables and heavy turbo-generators.

## Memory Systems for the Production Atlas

The first production model of FERRANTI'S Atlas digital computer is to have memory systems made by the PLESSEY Company. Plessey were the manufacturers of systems used in the prototype Atlas.

Two storage systems have been used for Atlas with access times of 0·35 microseconds and 0·6 microseconds. Plessey memory systems are described by the company as the fastest production types in the world.

One of the most comprehensive digital computing machines in existence, Atlas was developed by Ferranti engineers working with Professor Kilburn's team from Manchester University. Fully transistorised, the Atlas has an addition rate of approximately 1 million per second.

## CEGB Reshuffling the Regions

Under the reorganization which the CENTRAL ELECTRICITY GENERATING BOARD is to carry through in its regional structure the London Division will disappear. It is to be replaced by two new divisions, North Thames and South Thames, covering essentially the areas of the North and South Thames grid control districts.

In each region, except the North West, there will be a Regional Transmission Construction department, working under a Regional Electrical Engineer dealing with transmission construction work in the field. Divisions will be concerned entirely with the operation and maintenance of the power stations and transmission lines within their areas.

The present cumbersome omnibus names for the Board's regions are to be replaced by shorter geographical terms: Southern, South Western and South Wales will, for example, become South Western.

## Uranium Refining Plant in South Africa

South Africa, the third largest producer of uranium ore, has commissioned a £250,000 pilot plant for uranium refining at the Government metallurgical laboratories, Johannesburg. The uranium reserves of the Union are estimated to be the largest in the world. At the moment most of the 6,400 tons of ore produced each year are bought by the Combined Development Agency under contracts which have until 1970 to run.

The pilot plant will be capable of refining 100 tons of uranium a year. It will be the first to be built in South Africa. It is intended that its first purpose shall be as a research project for the investigation of refining methods for uranium metals and sales.

Nuclear fuels produced at the pilot plant will be tested at the SOUTH AFRICAN ATOMIC ENERGY BOARD'S reactor, which is expected to be completed late in 1963.

## AEI Cotton Mill Order for Phillipines

The complete electrical equipment for a cotton mill in the Phillipines is to be supplied by ASSOCIATED ELECTRICAL INDUSTRIES. Contracts for the mill, for the COTTAGE TEXTILE DEVELOPMENT CORPORATION were placed through PLATT BROTHERS (SALES) Limited, of Oldham, Lancashire.

Automatic power factor correction control equipment and capacitors, switchgear, transformers, fluorescent lighting, cabling and a 600 kVA ac generator, for use with a RUSTON-PAXMAN diesel engine are being provided by the AEI Motor and Control Gear division.

Platt Brothers (Sales) are supplying the preparation and spinning machinery. AEI are also to make the starters and electric motors for the cards and drawing frames.

# The Molins Fliptop Packaging Machine

**The lifeblood of the cigarette machinery industry is development—to introduce a machine which is technically better and from which the product is both an improvement and a novelty.**

THE MOLINS fliptop packaging machine is designed for one specific job—that of packing cigarettes in a particular kind of box. This box is generally known as the "fliptop"—or "hinge lid," to quote the manufacturers' terminology.

ENGINEERING have chosen the Molins fliptop machine for Product Profile by virtue of its tremendous popularity in the cigarette industry, which started in the USA. Success of a machine of this kind is inseparably bound up with the success of its product, in this case the fliptop packets, without which the services of the machine would not be required. What is the explanation for the growing popularity of the fliptop packet?

There are two basic reasons. Firstly, it is considerably stronger than the more conventional slide and shell cigarette packet, yet it still uses the same type and quantity of card material. And secondly it possesses a strong sales appeal by displaying a trend in styling that has "caught on."

Molins Machine Company Ltd., Deptford, London, SE8, are responsible for the design of both the fliptop packet and the machine to make and fill it. The firm are specialists in machinery for cigarette making and packaging—a highly specialized field which demands a certain "know-how" and special techniques that are inapplicable to other branches of the packaging industries. Packaging cigarettes demands a gentleness complementary to a positive action, due to their low mechanical strength and fragility. Cigarettes are delicate and must not be crushed or damaged in any way, either during packaging or in the course of their journey to the consumer. This is why the much greater strength of the fliptop packet is such an advantage, apart from the question of fashion.

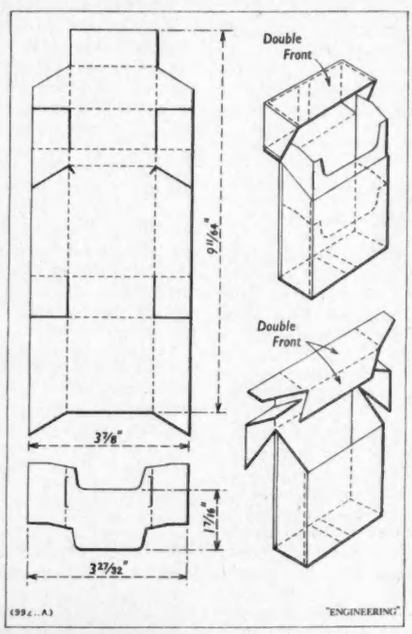
The origins of Molins Machine Company date back to 1874 when J. S. Molins, grandfather of the present chairman, commenced cigar manufacture in Cuba. In 1898 the firm of J. S. Molins and Sons was established in London to manufacture cigarettes and to introduce and import tobacco machinery. In 1912 the firm was reconstituted under its present name by the sons of the founder, Walter and Harold Molins, to specialize in the construction of cigarette machinery and to exploit Walter's inventions.

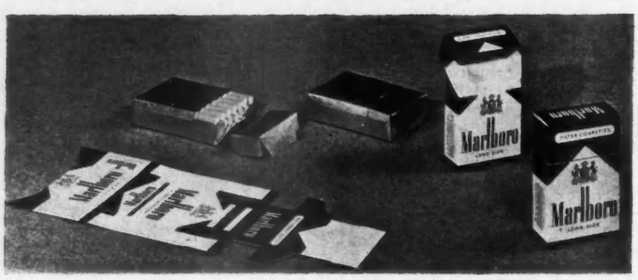
Molins machines soon established a world wide reputation for good class workmanship, advanced design and complete reliability. The company has expanded continuously since the early days and now supplies over half of the total cigarette making machinery in the world. This astonishing achievement is due to 100 per cent devotion to the tobacco industry and continuous anticipation of its future needs. During their long history Molins have introduced many machines of revolutionary design, and also made important improvements to existing equipment. They have also kept in the forefront of alterations in packet design to create new fashion trends, having originated several novel and successful packing styles in conjunction with the machinery to produce them. The joint success of the fliptop packet and packaging machine is, therefore, less surprising when this long record of success is taken into account.

## ORIGIN OF THE FLIPTOP

To return to 1912, Walter Molins' inventive flair was the root from which the company's busines sprang. His machines were all designed from first principles after a thorough study of the particular task being performed by hand. Walter's machines were all arranged on the principle of continuous rather than intermittent action, and thus right at the start they differed fundamentally from other machines.

The company's steady progress led in 1931 to the establishment of a subsidiary in Richmond, Virginia, to market and service tobacco machinery in the USA. It was also during the 1930's that the idea of the fliptop packet was conceived, which was followed by work on the design of a suitable machine. In 1938 a machine for making fliptops was sold to Churchmans in Great Britain, who were the first cigarette makers to try the style; but, unfortunately, wartime austerity conditions prevented further progress.




*Figs. 1 (above) and 2 (left) The fliptop cigarette packet and its various construction stages.*

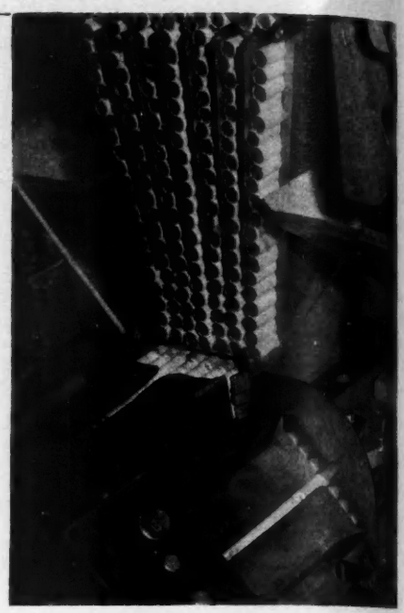


*Fig. 3 Cigarette hopper and grouping section for twenties; the rows are usually arranged 7-6-7.*

After hostilities ceased a few more machines were sold, mostly to Germany; but in common with many good inventions, it took time for the popularity of the new cigarette packet to become established. The average smoker tends to be conservative in his tastes, and production of the fliptop machine got off to a slow start. A "breakthrough" was badly needed.

Suddenly it came in 1953, when one of the leading American cigarette makers, Philip Morris Incorporated, changed over to the fliptop packet for its Marlboro brand. Sales of the brand at once rocketed to the extent of a 5,000 per cent increase in six months; a spectacular rise, much of the credit for which must undoubtedly go to the fliptop. Not unnaturally, other American cigarette makers quickly followed suit, and since then cigarette makers all over the world have been busy introducing fliptops, resulting in a continuous stream of orders for machines in an almost embarrassing quantity.

## ACTION

The action of the fliptop machine is essentially simple despite its complicated appearance. In the basic machine, cigarettes fed from a hopper are grouped into any number between 10 and 24 (usually tens or twenties) wrapped in foil and packaged. Devices for fitting a lifting ribbon or inserting a cigarette card can be built in if required. Further operations, such as cellulose film wrapping, revenue stamping and cartoning, can be conducted by "linked units," designed for use as extensions of the basic machine.

The fliptop box itself comprises an outer carton body and an inner frame, as shown in Fig. 1. The die-cut blanks for the outer body are supplied to the packaging machine pre-printed, cut and scored, while the card material for the inner frame is reel fed, creased and cut to shape without waste as part of the packaging function.

The foil is also reel fed and may be plain,

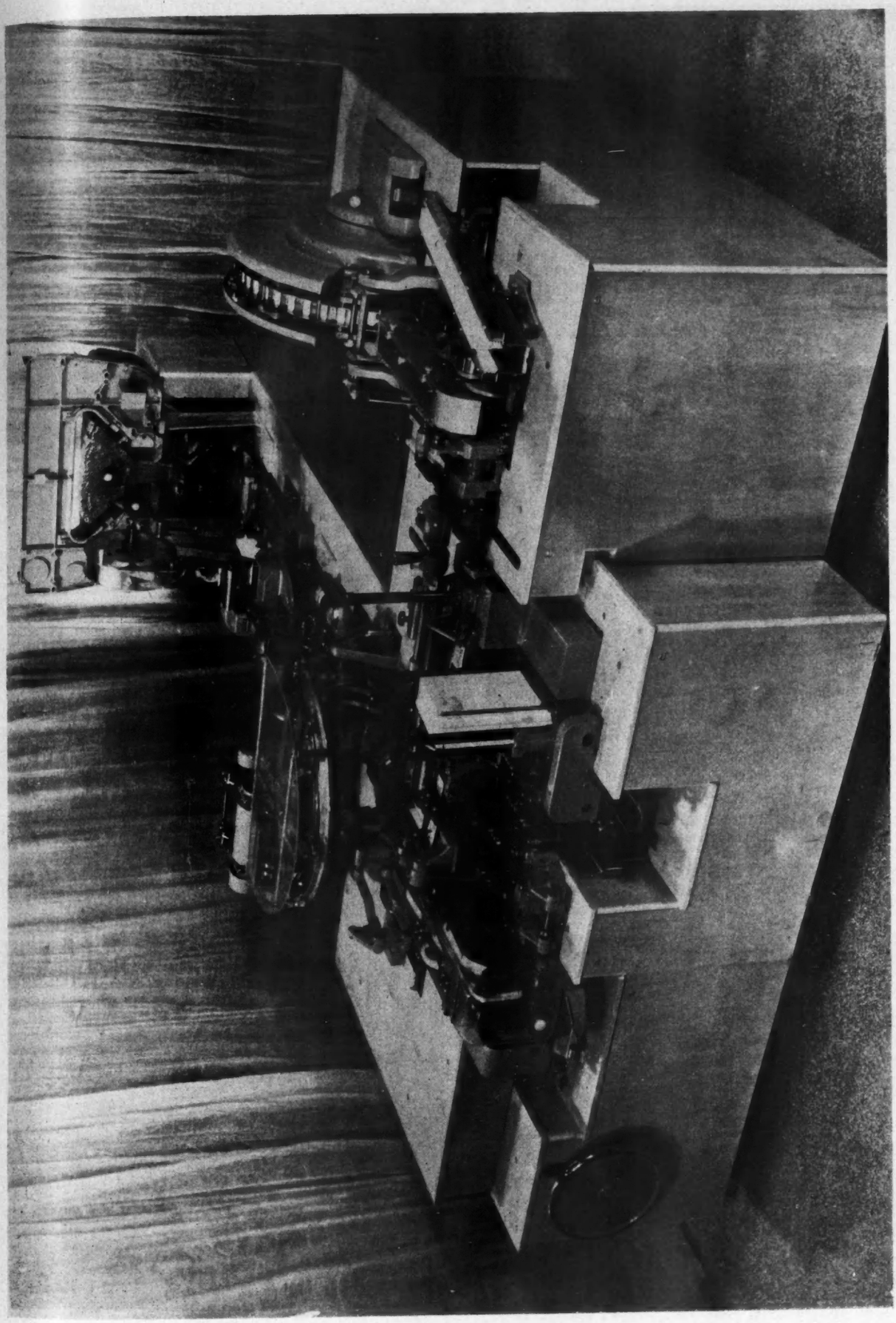


Fig. 4 Intimate liaison between manufacturer and customer results in a successful machine making a popular product.

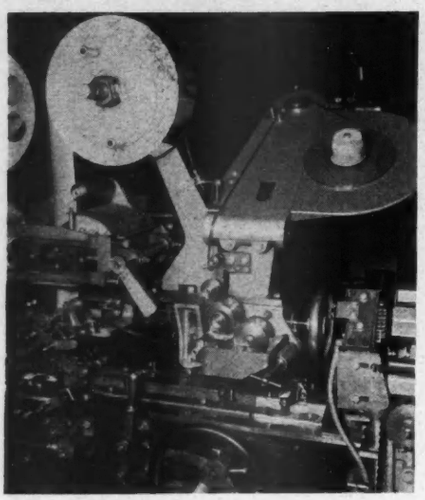


*Fig. 5 Foil wrapping section, with cigarette ends detector on right.*

pre-embossed or embossed on the packaging machine. Two optional features are the "loose front" on the foil bundle, which allows the upper part of the front of the bundle to be lifted off after opening the box; and the cigarette lifting ribbon which consists of a paper tape suitably arranged inside the foil, so that the first cigarette can be raised by pulling gently on the end of the ribbon protruding at the top.

After being grouped in the correct number at the base of the hopper, the cigarettes are presented to the ends detector, which ensures that the ends are undamaged before packaging starts. If any cigarettes are missing or the ends damaged, the group will be ejected. Groups of cigarettes for foil wrapping then pass to the pouch-forming section where the foil is cut and partly wrapped around them. Subsequent folding and tucking operations complete the foil wrapping before the inner frame is applied.

Meanwhile the outer carton body is fed from a magazine hopper and passed along a conveyor system in the course of which it is partially formed ready to receive the wrapped bundle and frame assembly. Once united, the main folding operations take place and the side flaps are glued and folded into position. The complete pack is then transferred to the drying drum where side pressure on the packet is accompanied by the gentle application of heat to ensure that the glue completely dries. The packets are then ejected on a take-off conveyor, which can be arranged to collate them in groups or to lead them direct to a cellulose film wrapping or cartoning linked unit.

Drive to the machine is provided by a 2 hp motor and the normal operating speed is 120 packets per minute. It takes just half a minute for a packet of twenty to complete the cycle. Operation is fully automatic and an electromagnetic fault detection system is provided. This system operates a number of fault-identification lamps and also gives indication when the cigarette hopper, magazine of outer blanks, and foil and inner frame reels become nearly exhausted. A box of cigarettes deficient of any item of its contents is automatically rejected without interfering with the machine's operation. Stoppage can, however, be caused by other outside factors, imperfect blanks for example, and occurs automatically.

A fliptop packaging machine linked to a cellulose film wrapping unit covers a floor area of about 11 ft by 9 ft, arranged in the shape of a "U." Ancillary units that can be mounted on the machine itself, for instance those for revenue stamping or applying the lifting ribbon, take their drive from the machine. Larger units, such as those for cellulose film wrapping or cartoning, are really other machines in their own right and have their own drive arrangements. They can be operated independently if required.

Due to abrasive action of fibre from the card material it is important to clean a packaging machine thoroughly once a day, and Molins can supply a water-lubricated air suction pump to assist in keeping the fibre away from the complex system of moving parts.

## MARKETING

Enough has already been said to show that marketing of cigarette making and packaging machinery is in a class by itself. An over-riding consideration is the high value of tobacco as raw material, due largely to import duty and tax. This factor spotlights the need for machinery for delicate handling, and also poses the problem of how to demonstrate a machine to an intended customer. For the appetite of a machine such as the Molins fliptop packer, which consumes nearly 2,500 cigarettes per minute in twenties, to say nothing of card blanks, foil and glue, cannot easily be satiated at the manufacturer's works, still less in the Exhibition Hall.

Here satisfied customers come to the rescue. In common with process plant, a machine actually working in a client's factory is the most convincing demonstrator, and ENGINEERING was fortunate in being invited to Carreras Limited's new factory at Basildon, Essex, where a number of Molins fliptop packers are installed. Here each machine keeps four girls busy, the machine operator having three assistants for feeding the cigarettes into the hopper, operating the cellulose film wrapping unit and boxing the finished products in cartons. In the words of the supervisor, "These are the best type of machines out for this kind of packing"; indicating that the Molins machines win on performance, reliability and maintenance; quite apart from the growing popularity of the fliptop packet.

The Molins Machine Company and their subsidiaries (which include the Thrissell Engineering Company of Bristol) now employ about 4,000. Their main offices and factory are at Deptford, and they also have a large extension factory at Saunderton in Buckinghamshire.

The fliptop packet represents the first fundamental change in cigarette packing for almost half a century, so it is natural to speculate whether it might not be equally popular for packaging foodstuffs or pharmaceutical products. It may be some time before this question is fully answered because Molins are hard put to it at present to keep pace with the demands of the cigarette making industry. An exception is the Nestlé Company Limited, who have recently introduced the fliptop pack, made on Molins machines, for a new brand of chocolate.

As a pointer to the company's pre-eminence in supplying the world, nearly 75 per cent of production is destined for overseas. Export sales are generally direct and to speed up delivery machines are sometimes despatched by air. Every machine is built individually to an order, complete with any special attachments as required by the customer. To date about 600 fliptop machines have been sold and production is still on the increase; now upwards of 140 cigarette brands in 30 countries are sold in fliptops.

Molins' research enginers are constantly looking towards the future, and work in a separate building in which only selected members of the staff are allowed. The company were among the first to introduce high speed cine photography into this country for research purposes.

The general tendency in cigarette machinery is towards increasing speed. The fliptop machine is not regarded as having reached the end of its development; though the factors limiting its speed lie in the characteristics of the packet materials, the board and glue, rather than in the machine.

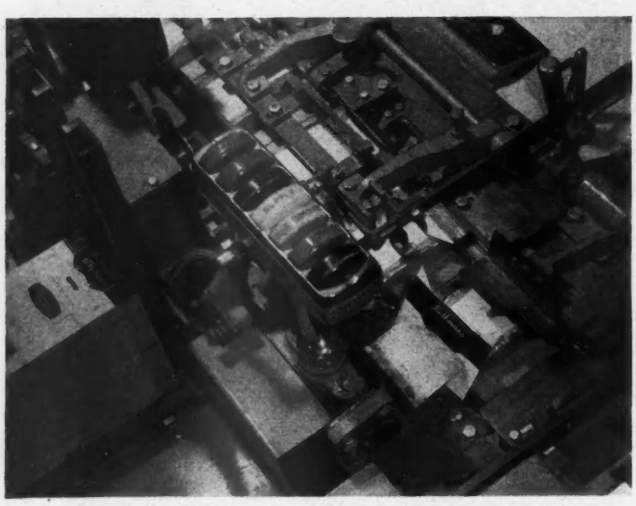


*Fig. 6 Conveyor section with packet being formed around foil bundle.*

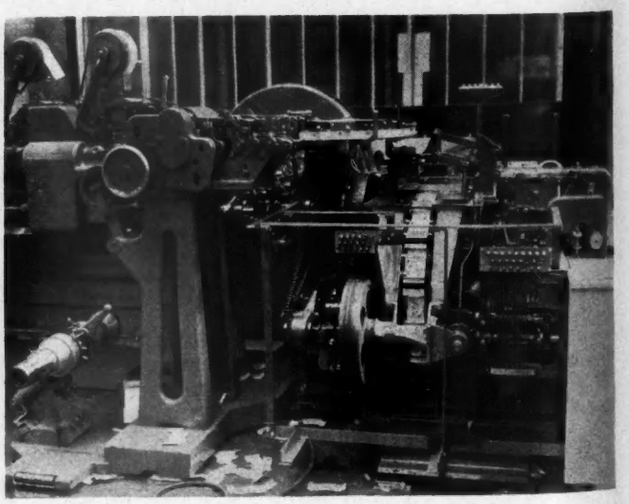


*Fig. 7 View during assembly, a long packet blank forming bed.*

# Research Progress in Japanese Electronics

It is, by now, common knowledge that Japan's electronics industry has made giant strides forward since the war, and is in now the forefront of world trade. Many factors, such as cheap labour, have contributed to this success but there is no doubt that their progress has been largely due to a recognition of the importance of fundamental research.

One of the better known Japanese electronics firms, Hitachi Limited, has a research compliment of 3,000, out of a total of 40,000 employees. Furthermore, they have now decided to centralise their research to one locality and have set aside a 57 acre site near Tokyo for development as a research centre. At the moment, the central laboratory has a staff of 1,000, including 300 graduates.

This laboratory has not only developed certain materials for components such as thermistors and fluorescent compounds, but also large-scale research equipment such as electron microscopes, mass spectrometers, electronic analogue and digital computers, television cameras and vacuum tubes for microwave operation. Commercial production of these items is now being undertaken by the different factories of the Hitachi group, both for the Japanese home market and for export.

Among other products, this laboratory manufactures radio-frequency transistors for an operating frequency of 900 Mc/s and at the moment it is engaged in developing rf transistors for operating frequencies in the 3 Gc/s band. Apart from intensive research designed to discover new materials, the institute is also engaged in investigating magnetic properties with the aid of high-power generators. Klystron multi-cavity tubes for operating frequencies of 2·8 Gc/s are also being developed.

At the present time, the development of electronic refrigerators and water coolers is in the prototype stage. As is well known, equipment of this type depends for its operation on the so-called Peltier effect and one of the great difficulties in the past has been the production of the necessary thermo-electric materials capable of providing the high power outputs required for this application. The Hitachi laboratory is engaged on the production of suitable materials of this kind.

In the development of large computer installations, Hitachi cooperates with IBM, but small computers have been produced and commissioned by Hitachi themselves in their own laboratories. For example, a Hitachi computer has been installed at the central Tokyo railway station to register seat reservations from various stations for every train passing through the system.

Another practical application of Hitachi computers is for automatic process control in chemical plants and one of these computers has actually been supplied to the Japanese atomic research centre. This piece of equipment is capable of integrating or adding and incorporates the necessary amplifiers and direction changers.

Computer development also extends to the field of machine tool control and a coordinate setter has been developed for a milling machine with a total spatial movement of 550 × 280 × 100 mm with a control pulse width of 0·01 mm and with a maximum speed of about 300 mm per min.

The laboratory has developed a hydrogen discharge lamp with an operating life of 2,000 hours and an operating voltage of 90 to 100 V for use in its own spectro-photometer which covers a continuous spectrum range of 2,000-3,600 Å.

The laboratory is also fitted with an anechoic room and a variable-density low-turbulance wind tunnel operating with a power of 3,000 kW is under construction.

There is no doubt that the extensive research activities and new central research laboratory have added considerably to the competitive strength of this concern, whose manufacturing programme includes a wide range of light electrical machinery, communications equipment, optical, medical and measuring instruments of all types, transistors, and heavy industrial goods such as rolling stock, industrial machinery, insulating material and so on.

# Lightweight Alloys for Space Engineering

Magnesium-lithium alloys, which are 20 per cent lighter than conventional magnesium alloys, are potentially of great value for space-flight, according to a recent report issued by the Battelle Memorial Institute, Ohio, USA.

Reducing the weight of space vehicles is vitally important because of the high ratio of booster weight to payload—up to 1,000 lb of rocket fuel for every pound of payload put into space.

Light structural components in a satellite and the upper stages of its rocket greatly increase the efficiency of the system, permitting larger, and more fully instrumented satellites to be orbitted.

Magnesium-lithium alloys appear to be the lightest metals suitable for structural use. Some of these alloys weigh only about three-quarters as much as conventional magnesium alloys, half as much as aluminium, and a quarter as much as stainless steel.

The elastic modulus of magnesium-lithium alloys at room temperature is equal to that of magnesium alloys. Therefore, the ratio of modulus to density is greater than that of magnesium, aluminium or steel. This means that magnesium-lithium alloys can provide stiffer structures at less weight. Although the alloys do not have particularly high strength (about 25,000 lb per sq. in) they should be valuable in space structures which need not carry heavy loads. Corrosion resistance of magnesium-lithium alloys is comparable with that of commercial magnesium alloys.

Another feature of these alloys is their excellent resistance to spalling and penetration by high velocity fragments. This might mean that they would be useful in protecting space vehicles or satellites against bombardment by micro-meteorites.

Magnesium-lithium alloys were first made by Battelle research engineers, some 15 years ago, in their search for light aircraft structural materials. The current research programme represents the first attempt to evaluate the alloys for space engineering applications.

# Rapid Removal of Sulphur from Steel

The refining period in an electric arc furnace, during which the molten metal is held under a white reducing slag for sulphur removal, is the time when the hydrogen content of the steel can increase adversely. With very low sulphur steels, the refining period may be quite considerable, however, it is possible to speed up the process and so reduce the danger of hydrogen contamination.

The Steelmaking Division of the British Iron and Steel Research Association have carried out a number of experiments in which powdered desulphurising reagents were injected directly into the metal bath of an electric arc furnace to bring about rapid sulphur removal. The experiments were divided into two groups: (1) injections into the metal with only a minimum of slag present, leaving the reaction products to form a new slag on the surface of the metal, and (2) injections under a white reducing slag.

The injections under a minimum of slag were carried out to show the degree of desulphurisation obtainable with a particular reagent, and the injections under white reducing slag were carried out so that the rate of desulphurisation with each reagent could be measured. The powdered reagents used in these experiments were burnt lime, burnt lime plus carbon, calcium cyanamide, calcium carbide, Rarement Compound (5), calcium silicide, and calcium silicide plus burnt lime. Mixtures of these, together with powdered aluminium or magnesium, were also injected.

For injection under a minimum of slag, the metal bath was put under a white reducing slag in a 10 cwt electric arc furnace until the sulphur concentration of the metal was reduced to approximately 0·015 per cent. The slag was removed almost completely and the desired quantity of powdered reagent, with or without deoxidiser, injected into the bath through 0·5 in class C tubing with oxygen-free nitrogen as the carrier gas. The reaction products from the injection were left on the surface to form a new slag. In each experiment, the lancing was divided into several parts so that the course of the reaction could be determined.

For the injections under slag, the metal bath was put under a white reducing slag in the electric arc furnace. Metal and slag samples and temperatures were taken at regular intervals so that the rate of desulphurisation for the slag could be determined. The desired quantity of powdered reagent was then injected and a metal sample, a slag sample, and a temperature reading were taken as soon as each injection was complete. The materials used for these injections were calcium-silico-magnesium, calcium-silico-manganese, calcium silicide and burnt lime plus magnesium powder.

The results of the two series of experiments show that steel can certainly be rapidly desulphurised to low levels by the injection of powdered reagents; but for quick desulphurisation to low levels the metal must be strongly deoxidised either by previous treatment or by an injectant containing magnesium or aluminium, either as an alloy or an element.

Reproducible sulphur values of about 0·005 per cent were obtained by the injection of calcium carbide or calcium cynamide into aluminium deoxidised metal baths and also by the injection of mixtures of calcium carbide, calcium cyanamide or burnt lime with magnesium powder into ferrosilicon deoxidised baths under the minimum of slag.

The most rapid desulphurisation to very low sulphur levels under white reducing slag was achieved when burnt lime with magnesium powder mixtures and calcium-silico-magnesium were used as the injectants. The rate of sulphur removal during these injections varied from 0·003 per cent to 0·007 per cent per minute. Negligible change was found in the sulphur concentration of the treated metal on tapping.

Further details of these experiments, including chemical reactions, approximate costs of injection on an industrial scale and total costs of treated steel, can be obtained from the British Iron and Steel Research Association 11 Park Lane, London, W1, quoting reference SM/AC/46/60.

# Ultra-High Pressure Effects on Solids

**Research on materials at very high pressures is relatively new to Britain. The work being carried out at the National Physical Laboratory covers both the measurement of physical properties and the synthesis of new materials.**

THE effect of very high pressures on solids, and here pressures above 10,000 bars will be considered as being very high, is of fundamental importance because such pressures can cause significant changes in interatomic spacing. In spite of this it can be said that this field has been neglected compared, for example, with low temperature research. In the last five years, however, the amount of effort on high pressure studies has greatly increased. One factor contributing to this has been the development of improved apparatus, and the incentive for much of this came from a successful effort to synthesize diamond.[1] It was the conditions necessary for this synthesis that led to the construction of apparatus capable of sustaining solids at steady pressures of the order of 100,000 bars simultaneously with temperatures above 2,000° C. It is this combining of high temperature and high pressure that is the main advance on the pioneer work of Bridgman,[2] and the effort is in large part due to H. T. Hall who designed the "Belt" apparatus[3] in which diamond was synthesized, and subsequently the original form of the tetrahedral apparatus,[4] a development of which is decribed below.

## Physical Changes

By subjecting solids to pressures of the order of 100,000 bars, many interesting physical changes can be made. Insulating and semiconducting materials can become metallic under pressure, and many crystalline phase changes can be observed. To aid these studies a variety of equipment is in use, particularly in the USA, which allows the measurement of optical absorption spectra and also of X-ray diffraction patterns, while the test samples are under pressure. In general such changes are reversible and the material reverts to its original state when the pressure is removed. There is, however, another type of change which can be "frozen in" and the synthesis of diamond from graphite, already mentioned, is an outstanding example. Others are the synthesis of "Borazon"[5] a cubic form of boron nitride which is a material of comparable hardness to diamond; and "coesite"[6] a high pressure modification of quartz. It is certain that many other such syntheses remain to be realised in the laboratory.

Still higher pressures of the order of one million bars have been obtained both in the USA and in Russia by the use of shock waves generated in explosions. These methods produce a pressure transient for a duration of less than one microsecond, and as yet measurements on solids have been limited effectively to obtaining the shock velocity. It is reported, however, that some syntheses have been obtained by explosion methods.

The equipment in current use in the Basic Physics Division of NPL for generating pressures of the order of 100,000 bars, is based on a design of the United States Bureau of Standards.[7] In this the high pressure cell is in the form of a solid tetrahedron, which contains the test sample embedded in a cavity in the centre. The four faces of the tetrahedron are squeezed together by an anvil pressing on each face, the anvils being arranged as shown in Fig. 1. The three lower anvils are held in a cone wedge and, when a load is applied by a simple press to the upper anvil and to this cone wedge, it forces all four anvils together. Fig. 2 shows the apparatus mounted in a press. To ensure the formation of gasket seals between adjacent anvils the tetrahedron is made slightly larger than the closure formed by the anvils.

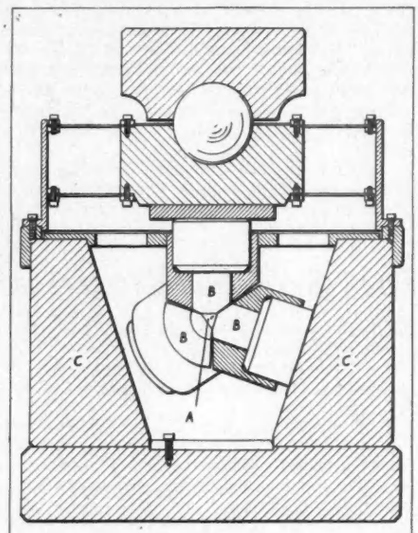



*Fig. 1 Tetrahedral ultra high pressure apparatus.*

## Construction

Fig. 1 is a sectional drawing showing the method of construction adopted by NPL; for clarity one of the lower anvils has been omitted from the drawing. To permit nominal pressures of the order of 100,000 bars being obtained from a press load of 200 tons an anvil with a loading face of 0·75 in edge length was chosen; the tetrahedron used is slightly larger, its edge length being 0·85 in. The anvil assembly is made up of three components; a tungsten carbide anvil 1·5 in diameter by 1·5 in long, backed by a steel block of 3 in diameter (made to British Standards specification EN26 hardened and tempered to 550 DPN), and these two components are held together by a ring which is shrunk on. The interference fit is 0·006 in on the tungsten carbide and 0·003 in on the backing block. The ring is also of EN26 steel, hardened and tempered to 420 DPN; the hole in the ring is finished to size after hardening and tempering to ensure that it is free from scale prior to the shrinking operation. The tungsten carbide used is Prolite grade 21A, which contains 5½ per cent cobalt. After assembly the loading faces are first ground to form, to ensure correct assembly, and then they are roughened by sand-blasting, this roughening also extends over the faces where the gaskets form. The wedge cone is made from a piece of 14 in diameter gun barrel steel, 3 per cent NiCrMo, hardened and tempered to 380 DPN.

Load is applied to the upper anvil through a 3 in diameter ball seating positioned on the wedge cone by a spring diaphragm arrangement. The upper anvil is additionally guided by a location plate which allows the anvils to be assembled correctly before the ball seating unit is positioned.

To ensure the correct location of the oversize tetrahedron cell during assembly, spacing buttons of Teflon $\frac{1}{16}$ in thick are inserted between the anvils; two buttons per interface are used, and these are spaced on the tungsten carbide inserts away from the zones of the gaskets.

Following the practice of the Bureau of Standards a 0·003 in sheet of Teflon plus a 0·002 in sheet of Melinex (Terylene) are inserted between the wedge cone and the three lower anvil assemblies; the Teflon acts as a lubricant while the Melinex provides additional insulation should the Teflon puncture.

The procedure adopted for the assembly of the test sample in the tetrahedron cell, and for its electrical heating, is as described by H. T. Hall[4] and the Bureau of Standards.[8] An illustration of such an arrangement is given in Fig. 3. Also included in this figure, at upper right, is a photograph of a tetrahedron, after it had been squeezed, showing the formation of the gasket seals.

## High Temperatures

By means of electrical heating of carbon or metal sleeves containing the test sample, temperatures of the order of 2,000° C have been obtained. To enable tests to be made at low temperatures hollow rings are shrunk on to the anvils, as shown in Fig. 4, and a cryogenic liquid, such as liquid nitrogen, is circulated around the anvils. By this means temperatures down to −150° C are readily obtainable.

The equipment is calibrated using P. W. Bridgman's fixed point resistance data for

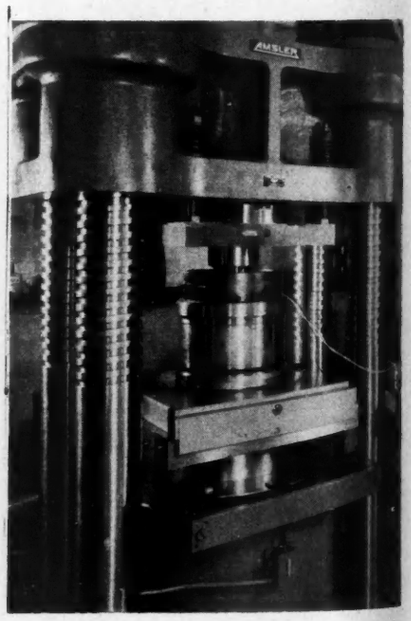



*Fig. 2 Apparatus in press. Gasket seals are ensured by making the tetrahedron slightly larger than the closure formed by the anvils.*

## Research Report

on the work of the

**Basic Physics Division, National Physical Laboratory, Teddington, Middlesex.**

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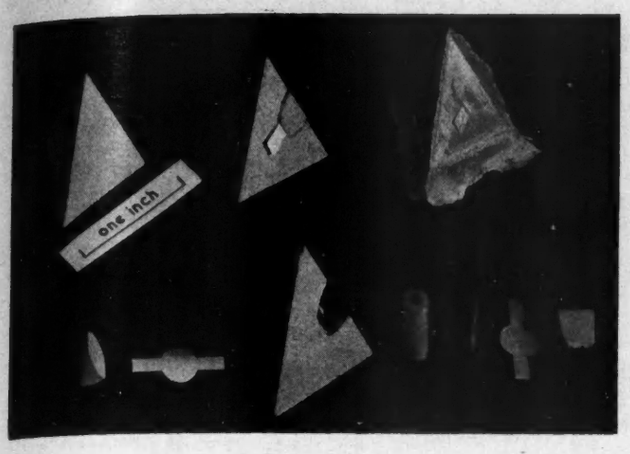


*Fig. 3 (left) Components of tetrahedron test cell. The lower set shows the various components disassembled. The upper right, a tetrahedron after use, with sealing gaskets formed by high pressure.*

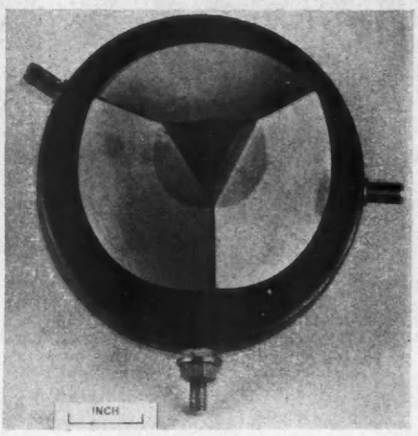


*Fig. 4 (right) Anvil cracked in service. At room temperature, up to 100 runs can be made before cracks appear; at high temperatures the life can be reduced to a few runs.*

bismuth, thallium and barium, and it is found necessary to calibrate for each arrangement of internal sleeving used.

It has been found that the tungsten carbide anvils crack when loads of 300 to 350 tons are applied, and for reasons of economy the maximum load is limited to about 200 tons. The cracks most in evidence are those formed around the edges of the extruded gaskets, although occasionally a radial crack will form in the centre of a loading face. A typical cracked anvil is shown in Fig. 4. It has been found that cracked anvils are still serviceable, particularly at lower pressures, and can be used until the gasket sealing faces break up.

The tetrahedron pressure cells are made of pyrophyllite, which is a readily machinable material, the small end filler caps were also machined originally, but these are now made by compacting pyrophyllite powder. The pressure inside the tetrahedron cell is not truly hydrostatic, and while this effect can be offset by the use of an inner sleeve of silver chloride it has been found advisable to keep the size of the test sample small. Bismuth wire of $\frac{1}{3}$ mm diameter is used in preference to 1 mm diameter wire for calibration, since a sharper transition point is obtained, and other test samples are restricted to about $\frac{1}{16}$ in diameter by $\frac{1}{8}$ in long.

As previously mentioned, the test sample is heated electrically and small strips of metal fitted in the tetrahedron assembly serve as conductors between the loading anvils and the heating sleeve. Strips of different metals are used according to the test in hand, 0·001 in thick silver is used when high conductivity contacts are required, 0·003 in thick nickel when mechanical strength is a major consideration, and 0·006 in thick annealed copper on occasions when it is necessary to conduct a high current.

## Measurement and Synthesis

The apparatus described above has been used for both types of research mentioned in the introduction, that is for measurement and for synthesis.

Fig. 5 shows graphically how the resistivity of the semiconductor indium antimonide behaves when subjected to increasing pressure.

First there is an increase in resistance which is known, from other studies, to be due to a change in the energy levels in this solid; but at about 30,000 bars the resistance suddenly drops and the substance behaves as a metallic conductor. It is not known at present whether this is caused by the material melting under pressure, or whether there is a transition to another solid phase of indium antimonide which behaves as a metal. The pressure at which the sharp change takes place increases as the temperature of the crystal is lowered.[8]

Fig. 6 is an X-ray powder photograph showing diamond lines. This photograph was obtained from early attempts at synthesis in the tetrahedral apparatus, using graphite as starting material and nickel as a catalyst. These experiments, at 80,000 bars and 2,000° C, were made only to verify that the measured pressure and temperature conditions had been realised, since the conditions for diamond formation have already been extensively studied by other workers. Fig. 7 shows a similar X-ray pattern of coesite made in the apparatus. Here the temperature was about 1,500° C and the pressure 45,000 bars held for 1 hour. The coesite is being used for optical investigations.

In conclusion, it can be seen that with comparatively simple apparatus an, as yet, little investigated regime of pressure and temperature can be obtained in the laboratory. This gives conditions of great interest to physicists, chemists and geophysicists alike for the study of physical properties, but for the engineer it opens up great prospects of making superior materials in respect of hardness and temperature resistance. It is surely an example of work where the closest collaboration of engineer, chemist and physicist is required, because the very products of research here may well be developed and used directly to improve apparatus for further research.

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this report is published by kind permission of the director of the Laboratory.

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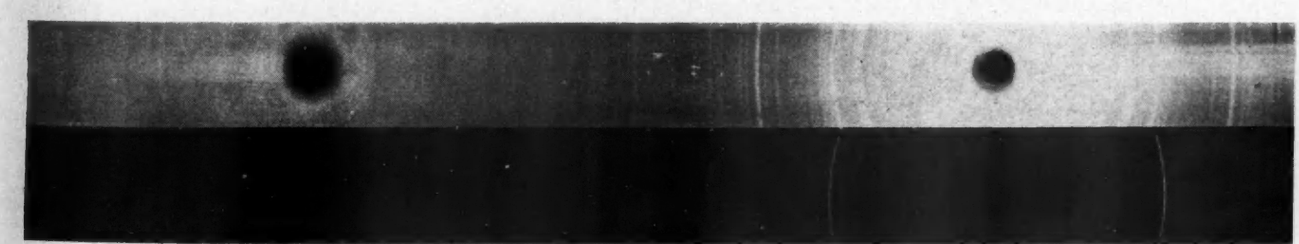

*Fig. 6 X-ray diffraction patterns of diamond dust (below) and synthesis from graphite and nickel.*

*Fig. 7 X-ray diffraction patterns of quartz (below) and coesite.*

# Double Oven

THE trend in domestic appliances is not entirely towards the small, great though the demands of space may be; both refrigerators and cookers are also expanding in the larger sizes, with the implication that there must be larger families and, somewhere, larger kitchens to accommodate them. One refrigerator from Kelvinator that came on the market last year is as big as most wardrobes.

Among the cookers, the Creda Constellation must be definitely counted among the larger family models. It is also one that has its full share of automation and all the latest additions. The controls along the top are is most impressive.

The Constellation has two large ovens each of 3,000 cu. in capacity (15 in by 14 in by 15⅜ in), each large enough to take a 28 lb turkey and trimmings. Both are at a convenient working height and have glass inner doors for observation.

The left-hand oven also accommodates the Rosta-Spit driven from a motor in the back. In the roof of each oven is a large grill capable of handling six slices of toast at once. Below the grill pan is a pull-out shelf to support the pan, leaving both hands free for serving. The grill in the left-hand oven can also be used to sear—seal—the joint prior to spit cooking or to brown poultry. Below the ovens are warming drawers of large capacity.

The hob has four Quick discs, all 7 in in diameter, one of which is extra fast and will boil a pint of water in less than 3 minutes. All have infinitely variable control.

The controls are all on the panel at the rear and each has its own pilot light. In the centre is a clock-timer unit and a 5-hour ringer. On each side are 13A sockets. The timer will control the left-hand oven, Rosta-Spit, left-hand warming drawer, and left-hand socket. The ringer can control the right-hand socket in addition to its normal use as a warning. The total electrical loading of the cooker is 12·2 kW.

Another double oven, but not so pretentious as the Constellation, is the English Electric model 2034 shown in the upper illustration. This has the ovens one above the other and so does not require so much floor space. Nor is the oven capacity so big. Three of the four radiant hot plates have simmer control and the fourth has an automatic device to prevent the contents of a saucepan boiling over. The lower oven is full size with a capacity of 3,200 cu. in and has thermostatic control from 150° F to 550° F. The automatic timer for it has a range of cooking times up to eight hours and of delays up to 11 hours. The upper oven is smaller and is controlled at 300° F. In the roof of it is a 2 kW grill measuring 12½ in by 8 in.

Controls for the cooker are at the back on the splash plate covering the ovens, grill and hobs and including the automatic oven timer and pilot lights. The whole cooker is mounted on rear rollers so that it can be drawn out for cleaning.

(*Left*) *There are two ovens in the model 2034, mounted one above the other.*

(*Below*) *The Constellation has two full size ovens, in one of which a spit can be fitted.*

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